Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Social and Educational Sciences
Department of Geography

Hedda Tomine Berg

How can we sustainably provide services in rural areas in the global south? A critical assessment of Lead farmers and Barefoot doctors' model for provisional extension services. Examples from Malawi.

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Abstract

This thesis studies agricultural extension services in Malawi and its long-term sustainability. This phenomenon was investigated by conducting an extensive literature review and analyzing the findings of the scholars, as well as by distributing a questionnaire and collecting data. The data was further analyzed, mainly with Python, to create correlations, significance levels, linear regression models and statistics of the values. The analyses were created to demonstrate the findings of the questionnaire with models for visualization, statistics for explanation and indications for reliability. The data collection and analyses were conducted to further analyze the scholars' results and statements, as well as to determine if the Lead Farmers model had existing limitations that would support implementing aspects of the Barefoot Doctors models. The thesis is based on the literature review and the findings of the data analysis serves as a mere indication and supplement to the literature.

The lead farmers initiative in Malawi is an agricultural extension service based on a bottom-up approach that seeks to assist farmers on their own merits. The farmer-to-farmer approach has a big role in improving the livelihood of the rural poor, as most of the rural population in Malawi are farmers. The Lead Farmers initiative is a model where farmers are chosen by the village to voluntarily undergo training in agricultural techniques/practices. Their task is to voluntarily lead other farmers and encourage them to learn and adopt these agricultural technologies. The Lead Farmers initiative has proven to have a positive effect in Malawi, but the model also has its limitations. This thesis found that for the farmer-to-farmer approach in agricultural extension services to be as effective and sustainable as possible one should also implement elements from other models. This thesis studied the effect of supplementing the Lead Farmers model with positive elements of the Barefoot Doctor's model. These are both models that focuses on training farmers in techniques that will assist them in helping other farmers, enhancing their life quality, and working towards resilience and self-reliance. The thesis found that implementing practices from the Barefoot Doctor's model like, longer and more comprehensive education/training, continued in-service trainings and livestock management training would effectively improve the outcomes and long-term sustainability of the farmer-to-farmer method.

Foreword

This thesis will seek to answer the question *"How can we sustainably provide services in rural areas in the global south? A critical assessment of Lead Farmers and Barefoot Doctors' model for provisional extension services. Examples from Malawi"* by analyzing existing literature and by using quantitative data. The topic of the thesis was chosen after having an internship with the Development Fund for approximately five months. The Development Fund is an organization that seeks to help the rural poor and enhance their livelihoods by focusing on agriculture. Their goal is to address farmers felt needs and to assists farmers by focusing on a bottom-up method instead of a top-down method. The initial work with the master thesis started in January, this period was utilized to conduct an extensive literature review. The literature as well as the book "Research methodology a step-by-step guide for beginners" were used to create the questionnaire (Kumar, 2011). The research tool "questionnaire" was used because it is easy to distribute, one can add many questions and it can be answered remotely.
Unfortunately, there was a setback with the data collection.

The data consists of the Development Funds extension workers in Malawi, they have extensive knowledge of- and experience with the Lead Farmers initiative. They are responsible for the management of the project and assist the farmers with education, they are the link between the Oslo office and the field, and they oversee the activities undertaken by the program. The DF Malawi office consist of five people with enough knowledge to consistently answer a questionnaire about the Lead Farmers project remotely. Because of this, the data is somewhat limited. For further work one should seek to conduct a fieldtrip to Malawi and organize a household survey with the farmers. Such a fieldtrip was not feasible for this master thesis as it would be time-consuming and costly.

I would further like to thank my supervisor, Thomas Halvorsen for great help and advice that he has offered me during the writing of this thesis. I would also like to thank family and friends, especially Terje Wigtil for helping me review the text and giving terrific advice for possible improvements. Finally I would like to thank Jonathan Eide for assisting with Python and the data analysis.

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Acronyms

SDG – Sustainable Development Goals

FAO – Food and Agricultural Organization of the United Nations

DF – Development Fund

OECD - Organization for Economic Co-operation and Development

LF – Lead Farmer

FF – Follower Farmer

AEDO - Agricultural Extension Development Officers

NGO – Non-Governmental Organizations

BES - Block Extension Systems

CA – Conservation Agriculture

CHW - Community Health Workers

IMF - International Monetary Fund

Chapter one

Introduction

The phenomenon this master thesis will study is combating rural poverty by focusing on agriculture. FAO (Food and Agricultural Organization of the United Nations) states that food and agriculture is at the heart of achieving each of the 17 SDGs (Sustainable Development Goals) (FAO, 2022). This thesis will study how to combat poverty by assessing if the Lead Farmers and Barefoot Doctors' models can help create low skilled front workers for sustainable agricultural development and poverty alleviation. These two models are initially based on different concepts, as one is about enhancing agricultural technologies and climate resilience while the other is about enhancing rural health. What both these methods have in common is using and training local farmers to achieve the goals of the models. Both models also work towards increasing overall life quality, eradicating rural poverty and difficulty as well as creating resilience among the population. This thesis will not focus on rural health, but on agricultural strengthening and adaptation skills. The Barefoot Doctors' model has proven to achieve such good results in Malawi that the thesis will seek to determine whether it can use parts of what makes this model so good to enhance the Lead Farmers model. These two models both have elements that can effectively and impactfully work towards eradicating rural poverty and improve agricultural extension services.

The contrast between quality of life in rural and urban areas is enormous. Two models called Lead Farmers and Barefoot Doctors are created to assess and attack the issue of rural poverty. This thesis will compare these two models to assess the most sustainable, relevant, effective and impactful way to reach the rural poor, based on the OECD (Organization for Economic Co-operation and Development) evaluation criteria. Lead Farmers and Barefoot Doctors are two primary service systems that could provide sustainable assistance in rural areas in the global south. Both models provide provisional extension services. Extension services are informal educational opportunities directed towards the rural population. This thesis is studying agricultural extension services. This service aims to offer advice, information and training to those who wish to participate in the project. The services intention is to increase the overall agricultural production, initiative disaster risk reduction, create better climate resilience and improve the overall living standard of the participants (Kalibata & Müller, 2021).

The goal of this thesis is not to dismiss one model, but it will investigate if the two models can supplement each other. The Barefoot Doctors' model has proven to achieve great results in Malawi. This model is based on individuals (mostly farmers and high schoolers) who partake a six months to three years long education/training in medicine. After finishing this training they will go back to their village and act as doctors (barefoot doctors). The barefoot doctors have basic medical knowledge and they use a checklist as a supplement to determine the illnesses and treatments of these illnesses. If they are unable to help the patient they will refer them to proper doctors in urban areas. The barefoot doctors will also gain a small salary and a pension.
The Lead Farmers model on the other hand is an initiative where a farmer is chosen by the village to become a lead farmer (LF), this farmer must go through a training course that lasts for approximately one to five days. After the training course is finished they are supposed to use their knowledge to train other farmers, called follower farmers (FFs). The Lead Farmers initiative is on a voluntarily basis and the LFs work for free. Because of the great results achieved by the Barefoot Doctor's initiative the thesis will seek to investigate if it can use elements of this model to supplement and enhance the Lead Farmer's model.

The topic of the thesis is also relevant for society as the whole world are all facing a wetter, dryer and wilder climate. Rising temperatures and more extreme weather conditions will affect everybody, but the consequences will be far worse for the global poor (Steen, 2014). During the last couple of years the population of Norway have experienced both dry and too short summers. This has resulted in ruined crops and damaged income for the agricultural industry. Luckily, the government in Norway has been able to compensate the farmers for some of the losses. Other countries lack these funds and might therefore face mass starvation and huge implications when their crops die during extreme weather changes. This suggests that new sustainable agricultural techniques are crucial in reaching SDG number two, zero hunger. By combating hunger, one will also pave the way for people to shift their focus from surviving to living. Their health will improve and they can use their days to focus on improving infrastructure, sending their children to school, as well as implementing more effective equipment like energy saving stoves. These stoves might in turn reduce women's workload as they don't have to walk for hours every other day to collect wood. Allowing them to send their girls to school, which in turn will boost gender equality. Another important aspect of teaching and training farmers in climate adapted agricultural techniques is that their

yields will get bigger, and they might experience a surplus which in turn gives them extra income which they can later use to further improve their well-being (Utviklingsfondet, 2020). Fighting hunger is a cornerstone in reaching every SDG, but what is the most effective and efficient method of reaching this goal? Ceres 2030 states that extension services play an essential role in fighting food insufficiency. By reducing food insufficiency one can increase life quality and pave the way for sustainable development (Kalibata & Müller, 2021). Therefore, the thesis will assess the Lead Farmer model and the Barefoot Doctor's model.

The research question is: *How can we sustainably provide services in rural areas in the global south? A critical assessment of Lead Farmers vs. Barefoot Doctors' model for provisional extension services. Examples from Malawi.*

1.0 Limitations

The initial plan was to create a questionnaire and distribute this questionnaire to multiple different parties. This was unfortunately not possible because it would be costly and time-consuming. The questionnaire was supposed to be answered remotely and it was intended to be distributed by email, Microsoft teams and with the help of the extension workers. This plan proved to be unviable as it would take the extension workers a huge amount of time to spread the questionnaire and recollect it.

Furthermore, the rural population in Malawi often lack internet, they are mostly illiterate, and they don’t have access to resources that would allow them to answer the questionnaire. To be able to distribute the questionnaire to the farmers one would have to go to Malawi, travel to the villages and then go door-to-door. One would then have to conduct an interview-based survey/questionnaire individually with each farmer. It would take many months to interview LFs and FFs, funding would be necessary, and one would need means of moving around and a translator as there is roughly 16 spoken languages in Malawi. This was unfortunately not feasible for this master thesis, but it would be necessary for further work.

Because of this setback, the discussion section will be based on the literature review, the data analysis will also be included in the discussion section, but only as an indication for the results and not as a key conclusion for the initial problem statement. Because of the limited

data, the literature review is extensive, and it includes many scholars who have conducted broad data-collections of the Lead Farmers initiative in Malawi and of the Barefoot Doctor's initiative.

1.1 Reader's guide

The thesis will start by describing why this topic was chosen and how the Development Funds Lead Farmers project is operated. Chapter three will study the theoretical framework that will be used for interpreting the results. This framework consists of an extensive literature review and of criterions for evaluating the long-term sustainability of the project. Chapter four will provide a descriptive explanation of the methods used to analyze this thesis. It also seeks to describe that due to the limited data, the conclusion will mostly be based on literature. Nevertheless, the data analysis will be an indication for further work and a supplement to the literature. This section also seeks to discuss the ethical considerations of conducting research and what one should have in mind when studying others. Chapter five consists of the data analysis; this chapter demonstrates the variables used to create the analysis. This chapter entail descriptive explanations of the variables, correlated variables and linear regression models that seek to display the effect of the correlated values. Chapter six is the discussion section; this chapter seeks to analyze the results and the evaluation criterions to determine causes and effects of the outcomes of the Lead Farmers and Barefoot Doctors' models. It seeks to determine the causes and effect to create ongoing action-learning to achieve the best possible results and to determine the best possible methods to provide services in rural areas in the global south. Chapter seven comprises of recommendations for further agricultural extension services, this chapter seeks to give recommendations for improvements to the Lead Farmers model based on the literature review. Chapter eight is the conclusion; this chapter will sum up the findings of the thesis as well as future research possibilities. Chapter nine is the bibliography section and chapter ten are the appendix, the appendix displays the excel sheets, the commands used in R and Python to create the data and the models, as well as the questionnaire.

Chapter two

Background/actualization

The topic was chosen after working with the Development Fund (DF) from august until December 2021. DF works with the Lead Farmers project in Malawi. This paper will review literature and studies of several scholars to compare the Lead Farmers initiative and the Barefoot Doctor's initiative to assess if the two models to supplement each other. These two models have the potential to enhance each other and make agricultural extension work more effective, impactful, relevant and sustainable. The Barefoot Doctor's initiative has had a remarkable positive improvement for children mortality rates in Malawi. Because of this the thesis seek to investigate what makes this model so beneficial and if one can use aspects of this model to further improve the Lead Farmers model.

DF created extension services in Malawi as a response to the lacking capacity in consistency among the multiple organizations operating this program. They have a close collaboration with both the government and other organizations to create reliable information and consistent knowledge transfer. The Lead Farmers method has been criticized because there are too many organizations operating this model without cooperating with each other. The Development Fund and its partners in Malawi created the first extension services guide: The Lead Farmer extension and training guide, in collaboration with the government and other Non-Governmental Organizations (NGOs). This guide has later been used by the government and multiple other NGOs, creating a more stable and reliable flow of knowledge transfers (Andersen, 2019).

The setup of the Development Funds Lead Farmers project is arranged subsequently: The DF generalist partner are the first to introduce lead farmers approaches in new areas. The Area Development Committee and Village Development Committee must approve the program. If they approve it the Village Development Committee chooses the Lead Farmer (LF). The process is facilitated and supported by the DFs partner. Lead Farmers must work voluntarily and the selected LF gets a five day long training course in agricultural services like sustainable agriculture, climate smart agriculture and conservation agriculture as an integral element. They will be offered a three days long refreshment course after two years of voluntarily working as an LF. They inform their Village development committee what they

have learned after receiving the proper training. They then move on to couch other community members on the technologies and the practices they have learned. Farmers who wish to learn from LFs must sign up and thus, become follower farmers (FF) (Andersen, 2019).

The agricultural techniques used in the Lead Farmers method is said to be mitigating the effects of climate change. It helps farmers create resilience against wetter, warmer, dryer and wilder climates. It allows farmers to improving their soil quality by teaching them new and sustainable cultivation techniques. How to combat soil erosion, how to produce higher yields and how to properly store water in the soil. This is all techniques that will allow farmers to adapt to the changing climate and to help them achieve a better life quality (Andersen, 2019). These techniques and many more are supposed to help farmers combat rural poverty, hunger, starvation, inequalities and improve previously failing agricultural technologies.

Chapter three

Theory section

3.0 Theoretical framework

How can we sustainably provide services in rural areas in the global south? A critical assessment of Lead Farmers vs. Barefoot Doctors' model for provisional extension services. Examples from Malawi.

This chapter will study the theoretical framework that will be used for interpreting the results. It seeks to describe the concepts, theories, existing knowledge and relevant scholarly literature. The primary purpose of the theoretical framework is to explain the meaning, the nature and the challenges related to the phenomenon being studied (USClibraries, 2022). The framework helps identify which factors affect and influence the phenomenon studied.
It also seeks to investigate how these factors might differ, how they might affect each other and under what circumstances this happens (Lederman & Lederman, 2017). This chapter will consider previously built knowledge of the Lead Farmers model and the Barefoot Doctor's model. The chapter will also present specific theories and terms that will be used to discuss the results of this thesis. Theories and terms included in this chapter:

- Extension services
- Lead Farmers
- Barefoot Doctors
- OECD evaluation criteria; Relevant, Effective, Impactful & Sustainable
- Sustainability; Institutional, Financial, Technical & Motivational

All these theories and concepts are important for the research and they will help evaluate the findings of the thesis. The OECD evaluation criteria and the Sustainability criteria provides the framework that will be used to measure the worth and merit of the Lead Farmers and Barefoot Doctors' interventions. They will serve as a basis for which the quality of the models will be evaluated as well as the means and the measures taken to provide quality extension services. It is important to evaluate the OECD criteria to determine the effects of the initiatives and if the effects are relevant, effective, impactful and sustainable. It is also important to evaluate the sustainability aspect to ensure the capacity to continue project activities at every level. It is important to develop mechanisms for investigating causes and

effects of the outcomes of development programs to create ongoing action-learning to achieve the best possible results and to determine the best possible methods to achieve these results.

The approach to answering the research question is feasible because the theory section is based on an extensive literature review that analyses the strengths and the weaknesses of the models. This research will further be used to discuss possibilities for enhancing the agricultural extension services in Malawi and it will be supplemented by primary data collected through a questionnaire and analyzed with R and Python. This thesis will bring new perspectives and knowledge because there has never been an extensive study investigating if these two models combined would enhance the effects and results of agricultural extension services. This thesis will investigate utilizing the synergy between the Lead Farmers model and the Barefoot Doctors' model to assess the questions: "*How can we sustainably provide services in rural areas in the global south"* and *"Can the Lead Farmers and Barefoot Doctors' models help us create low-skilled front workers for sustainable agricultural development and poverty alleviation".* The Barefoot Doctors' model has had a successful effect on rural health in Malawi. Therefore, during this thesis, this thesis seeks to determine if we can use elements from this model to improve or enhance the Lead Farmer's model.

3.1 Extension services

The role of an extension worker is development. Extension workers are individuals employed by the government, NGOs etc. They work to ensure good quality training of Lead Farmers and to make sure that the project works properly and effectively. Extension workers are also the link between farmers and the organizations who run the extension services. An extension worker is a person who is responsible for providing knowledge and information to lead farmers. This will enable LFs to gain knowledge and training in a specific field. The LF will then use this knowledge to teach follower farmers. This is supposed to enable the FFs to understand and adopt new innovations and agricultural technologies. Extension work can be explained as "transfer of knowledge/skill" (Kalibata & Müller, 2021). Both the Lead Farmer and the Barefoot Doctors' model is based on provisional extension services. Extension services is a very important element in fighting food insecurity globally. Extension services allows farmers who has received the proper training to use and cultivate their land as effectively and sustainable as possible, which in turn might lead them to get the most out of

their farm. In addition, when farmers use the land in a sustainable and adaptive manner it ensures proper soil fertility for them and for future generations. This is a cornerstone in sustainable development and reaching the SDGs. Sustainable development is when one preserves the needs of today's generation without compromising the ability of future generations to meet their needs. Combating food insecurity, malnutrition and vulnerability as well as fighting soil degradation might be ways to reach the SDGs (Kalibata & Müller, 2021).

Malawi is a country that is rapidly experiencing climate related challenges. Soil degradation, floods, crop pests and water scarcity are some of them. It is vital to solve these challenges as people will face worsened food shortages, malnutrition and hunger without a viable solution. It is essential to have extension services in situations like these, as these services will give farmers the opportunity to learn crucial techniques that can help them get the most out of their farms and to become more resilient (Andersen, 2019).

3.2 Lead Farmer model

The Lead Farmers model, often described as the farmer-to-farmer method is an extension service based on training a farmer who is chosen by the village in agricultural techniques/practices (Tchuwa & Simpson, 2015). The name Lead Farmer derives from their task, voluntarily guiding/leading other farmers and villagers in sustainable agricultural techniques that will help them face the changing climate and create resilience and the ability to adapt (Andersen, 2019). The farmer-to-farmer approach has become so popular in Africa because it is based on more trust between farmers and fellow farmers. It costs less than using extension workers in the field and it is perceived to be more sustainable (Tchuwa & Simpson, 2015). The Lead Farmer approach is related to the term social learning, farmers learn from and teach each other (Ragasa, 2019). Lead farmers are farmers who are chosen by the community to learn a maximum of three agricultural technologies and then put this new set of skills forward to new farmers (Malindi, 2015).

Another important aspect of the Lead Farmers extension service is the introduction of livestock. The lead farmer is given a certain number of livestock, and through a pass on system he/she must give livestock to another farmer when their own livestock becomes pregnant and produces offspring. This is supposed to be a never-ending cycle, the next FF

must do the same and pass on his/her livestock offspring to a new FF to create a continuous cycle of livestock given to the community (Utviklingsfondet, 2020).

3.3 The Malawi governmental Lead Farmers approach

The agricultural extension services in Malawi began during colonial times in 1903. A demand to increase agricultural productivity, supply and export raw materials to Europe, as well as reduce land degradation due to extensive cultivation and opening of new land led to the necessity of advisors and advisory services (Malindi, 2015). Master farmers/privileged farmers who were already better off than the rest were trained to act as advisors and demonstrators. They received governmental support on the basis that other farmers would follow their recommended agricultural practices. Nevertheless, many farmers did not follow the recommendation of the master farmers because of jealousy and because they were believed to work for the colonial government. After independence in 1964 the master farmer approach was changed to progressive farmer approach (Malindi, 2015).

Modified Training and Visit Extension known as Block Extension Systems (BES) approach was implemented in 1980. The BES was implemented to improve farmers coverage with agricultural extension services. The BES assumed that farmers lacked the skills needed to cultivate a field, hence, fortnightly trainings came to be. Farmers were supposed to work and train in clubs and groups to increase the overall coverage. In reality this led to the increase of operational costs. These services were mostly used for farmers to access credits, thus, leading poorer and "unworthy" farmers to be marginalized (Malindi, 2015).

During the 21st century, agricultural extension services was created to meet demands and needs with a bottom-up approach. This indicates that farmers and other beneficiaries should be able to decide if and how they want to receive help.

3.3 Literature review of the Lead Farmer's model

Tchuwa & Simpson (2015) noted that the core assumption of the Lead Farmers method is that farmers learn better from fellow farmers than outsiders. Their analysis states that desirable traits in a lead farmer is being and active farmer and hard-working, they must enjoy helping

others as well as being respected in the community. It is especially important for the community that lead farmers are experts in their domain and have a lot of knowledge of agricultural technologies. They noted that it is often the organizations and not the lead farmers or follower farmers who decides what technologies that will be disseminated. It is believed that the Lead Farmers initiative is more effective if one targets farmers felt needs and allows them to decide what training they need. 36 percent of the farmers stated that they conducted their own needs assessments, 18 percent stated that their needs assessments are conducted by field extension workers, 31 percent of the farmers stated that they merely teach what they have been thought without having a say in it and 13 percent responded that they respond to farmers requests and teach what they state that they need (Tchuwa & Simpson, 2015).

Tchuwa & Simpson found that 45 percent of the respondents stated that the initial training to become an LF lasted for just one day, 19 percent answered that their training lasted for two to three days and 27 percent stated that their training lasted for more than five days. When the respondents were asked about which topics they were thought during the training, only 69 percent of the respondents mentioned technical topics such as agricultural technologies and farming methods. 70 percent of the same respondents mentioned non-technical topics as extension, communications and facilitation skills. Only 43 percent of the farmers in Tchuwa & Simpson survey reported that they received training materials to help them to do their work. Only 54 percent reported that they received materials for demonstrations, such as seeds, implements and fertilizers. They also reported that those LFs who worked with the government received seed and fertilizers more frequently than LFs working with NGOs. Farmers stated that they met with their LFs once every week and more often during the rainy season when their crops are planted. Merly 44 percent percent of the respondents answered that they had received additional training after the initial course (Tchuwa & Simpson, 2015). They specify that if lead farmers where to gain a salary they might be perceived as another class and no longer “equal” to the fellow farmers. Volunteering is perceived as an altruistic activity that will enhance individuals’ quality of life by producing a feeling of accomplishment and self-worth. The most common answers when they were asked why they wanted to be LFs was, obtaining knowledge to improve their own farms, altruism, early access to new technologies and because they can take part in income generating activities (Tchuwa & Simpson, 2015).

Ragasa (2019) noted that LFs were not effective and that they performed at a substandard level, meaning that they are falling short in their tasks. Her analysis also shows limited results, limited coverage and weak implementation at a national level. She states that only 13 percent of farmers reported having received agricultural advice from an LF during the last two years and only 20 percent had interacted with an LF. Their economic models also show that farmers who interacts with LFs and have access to advice show limited effect of awareness and adoption of the major agricultural practices being promoted by the program. Her analysis shows that there are three key factors in reaching good results from the program. It is the quality of LFs, the adoption behavior of LFs and the regular training of LFs (Ragasa, 2019).

Ragasa states that there might be various historic and social factors indicating that there might be limited effect of the LF approach and the impact and performance of LFs in their communities. For example, Malawi has a long history of privileged farmers who have been supported with subsidies and inputs in the past. This is still an issue today and some community members have stated that the selection process to be an LF and to gain livestock, surplus and income at an early stage is biased. They believe that progressive or elite farmers has been cherry-picked before other farmers and therefore obtained privileges because of their status. In addition, some farmers have previously stated that the LF training is too short which in turn might lead to knowledge drain and poorer training of FFs. The quality of the LF training is very important to ensure a long lasting and good program. Another issue with the Lead Farmer model is that some young people fall out of the program because it takes too many years for them to see or experience any significant change (Ragasa, 2019).

Andersen (2019) noted that approximately 60 percent of the target group has benefitted from the program and that the amount is continuously rising. She claims that the yields have increased and that many farmers have managed to expand their production and production areas. She indicates that crop rotation and intercropping has contributed to better nutrition and that food insecurity has decreased. She states that every agricultural technology has become more resilient and fruitful, that soils have improved, the water storage capacity has improved, and the average household income has increased. She also states that women have reduced their workload and that they have been able to halt soil erosion using agroforestry and restoration of tree cover (Andersen, 2019).

Andersen believes that the LF trainings should be longer and more extensive. She recommends starting with 15 days of training which is divided in three parts with a break between each part, allowing the LFs to reflect and practice what they have learned. She also believes that there should be refreshment trainings every year (Andersen, 2019). She also believes that livestock should be distributed in greater numbers to ensure that everybody will receive their animals before four years has passed. This will ensure that people do not drop out of the program because they must wait almost a lifetime to receive any benefits from the program (Andersen, 2019).

Fisher, Holden, Thierfelder & Katengeza (2018) states that conservation agriculture (CA) has increasingly been adopted by international organizations as a method to aid small-holder farmers in rural areas. CA techniques is used to achieve greater agricultural productivity, increased income and enhanced food security while simultaneously protecting and preserving the resource base. CA is defined by three key principles, crop diversification through rotation or intercropping, minimum soil disturbance and crop residue retention. Fisher, Holden, Thierfelder & Katengeza found that CA techniques and increasing familiarity and adoption of for example, mulching, organic manure and minimum tillage is more effective when organizations use lead farmers to conduct the trainings, distribute the knowledge and create familiarity among the village members and other farmers (Fisher, Holden, Thierfelder & Katengeza, 2018).

Their study suggest that lead farmers are more effective in creating familiarity and awareness of the CA techniques than they are of encouraging other farmers to adopt the technologies. Their analysis shows that lead farmers are often younger and operate larger farms, have greater wealth, have better labor availability and are more educated than follower farmers. They state that LFs and FFs have heterophilous ties. Heterophilous networks is the relationship between lead and follower farmers, which are more important in prompting awareness of new technologies and innovations. This is because new ideas often arrive through a system of individuals with higher status that are also more innovative. Homophilous networks is the relationship between follower farmer to follower farmer, this relationship is often more effective in prompting other farmers to adopt new innovations and technologies. They found evidence for this statement in a case of pit planting and composting in Malawi. In this study peer farmers (peer farmers have the same status as every other farmer in the village) performed better than lead farmers (who in this study appeared to be wealthier, progressive

farmers) at encouraging adoption of CA technologies among a randomly selected sample of farmers. The peer farmers who had the best success was those who were most like other farmers in terms of resource access (Fisher, Holden, Thierfelder & Katengeza, 2018).

Mulwafu & Krishnankutty (2012) states that lead farmers are individual farmers who are chosen by the community to teach agricultural technology specific farmer-to-farmer extensions and they are themselves trained in the technologies by extension workers. They express that the Lead Farmers initiative has had a positive impact on increased livestock and livestock activities in Malawi. By addressing the occurring issues of farmers handling of livestock one can experience the immense potential of livestock development in Malawi (Mulwafu & Krishnankutty, 2012).

Their analysis indicates when farmers are poorly trained experience high death rates of livestock. This leads to an enormous loss for the farmer and the community because it affects the livestock pass-on system. Extensive livestock training of lead farmers is necessary to avoid this issue. Useful trainings are development of leadership skills and livestock management training: breeding, housing and feeding, as well as disease and pest management. It is also important to conduct training in administration of drugs to livestock in the communities since there is a limited number of veterinarians in rural areas. Furthermore, it is essential to teach and preserve establishment and management of fodder and feed preservation and formulation. It is also important to teach farmers to keep proper records of their livestock to combat the rising inbreeding cases in Malawi. They express that livestock seeds, fodder, drugs and small stock should be included in a package received by the government, NGOs, organizations etc. These packages are essential if the farmers want to timely implement livestock activities like construction of livestock houses, farm design and creating fodder fields. Mulwafu & Krishnankutty states that it is important to have consistent supervision of the farms and farmers' progress. It is important to visit the farms and provide on-site advice to encourage and motivate the farmers to properly take care of their livestock. If extension workers and lead farmers rotate the farms they visit and visit them continuously they will motivate the beneficiaries to become more committed to improve their livestock activities (Mulwafu & Krishnankutty, 2012).

3.5 Barefoot Doctors' model

The Barefoot Doctor's model was developed by Mao Zedong and is a Chinese model for rural strengthening/development. It was developed in response of a lack of doctors and medical staff in rural areas in China. No educated doctor would move to a rural village to work, resulting in high mortality rates, untreated sicknesses and poorer life quality among the population. This model is partly responsible for the great improvement in health indicators of the Chinese population since 1949. Because this model was so successful in China, multiple countries in the global south started practicing it as it is an efficient and much cheaper way of increasing the overall populational health standards in a country. India, for example, has created a barefoot college and barefoot teachers. The Barefoot Doctor's initiative was much in line with Mao`s belief about local selfreliance and the selfless service of the individual (Haklev, 2005).

The model was based on providing farmers, herbalists and individuals with a high school level education with a minimum of a six month long medical education. The training was often held during the winter, during the agricultural off-season. The barefoot doctors were mostly farmers, they spent 1/3 of their time on herb gardening, farming and health work. The farmers were often hand-picked from villages because it made them much more likely to want to go back to the village when the education finished. The idea was that they would acquire basic knowledge of patient examination, diagnosis, and treatment. This, in turn, would allow people in rural areas to acquire medical help from those trained without delay. The barefoot doctors would get a small salary which would motivate them to continue the work. If the barefoot doctors not were able to figure out what diseases they suffered from or treatment to use on their patients, they referred them to educated doctors in urban areas. The initial training/education of minimum six months was only the preface. To prevent knowledge drain they invented the concept of continued in-service training. This training would be provided by mobile medical teams. The idea was that eventually 15 percent of all doctors would be stationed in urban areas on rotation. The doctors would then treat complicated cases, learn from and of the villagers/farmers, as well as continuing the training of the current and new barefoot doctors. In addition, all the barefoot doctors were given manuals of local illnesses and treatments. Finally, classes were available for barefoot doctors who desired to upgrade their training and knowledge, and for those who hoped to get into medical school. This in turn gave preference to the concept of barefoot doctors with experience. The

difference between village health workers in other countries and the Barefoot Doctor's model is that the barefoot doctor is a farmer and a health worker simultaneously. This makes the Barefoot Doctors' model unique as it led to a degree of homophily (the same socio-economic background) which was not found in other systems and countries. This system was led by Mao Zedong's ideal of breaking down hierarchal relationships. Practicing the Barefoot Doctors model meant that the "doctor" and the patient would have roughly the same socio-economic background. Having roughly the same socio-economic background causes an increased understanding of the patients' situations, and it might lead to enhanced disease assessment and treatment (Haklev, 2005).
This model led to an increase in quality of life for the rural poor. Health knowledge is often very poor in rural areas so providing basic medical knowledge is enough to increase general health, life expectancy and quality of life (Haklev, 2005).

3.6 Literature review, Barefoot Doctors

Perry (2013) states that the first community health workers (CHWs) derive from China, and they were called "Farmer scholars". They were trained during the 1930s in China and were the predecessors of the barefoot doctors. Though the first example of formally well-trained non physicians to carry out assignments and responsibilities that were normally given to physicians were in Russia. These formally well-trained non physicians were called the Feldshers. These people were individuals that were trained as paramedics to assist physicians and/or to act in the physician's place in rural areas, much alike the Barefoot Doctors' model in China. Feldshers was also local people with limited training authorized to provide primary health care in rural areas. The Feldshers can be seen as the predecessors of CHW. The CHW approach encountered some issues before the 1980s, inadequate training, insufficient incentives and compensation, insufficient continuing education, insufficient supervisory support, poor integration with the healthcare system and poor acceptance by educated health workers and doctors. The CHW approach failed in the 1980s and 1990s due to the global recession and the structural adjustment programs that followed the debt crisis after the recession. The International Monetary Fund (IMF) and the World Bank forced these countries to embrace free market reforms and to reduce their public sector financing. This meant that there were no longer any resources to fund the CHW initiative and similar initiatives. Because of this the mentality also changed. People started believing that these programs represented

"second class care" and the priority was again shifted to focus on health care that affected urban and elite population. This had a notable influence on government decisions regarding health care initiatives (Perry, 2013).
Though there was a big setback during the 1980-1990s, more recently many countries have again begun to invest in and create CHW programs. For example, there is a CHW program in Pakistan called the Lady Health Worker and it has since 1992 gradually increased to serve up to 70 percent of the rural population, with is approximately 100 000 workers (Perry, 2013).

Patel & Nowalk (2009) states that due to poor immunization coverage in India many easily preventable diseases have been borne by children under five years of age. To meet the needs of poor healthcare services in rural areas India is making a new national community health worker plan. They stated that only 44 percent of children between the age of 12 to 23 months were fully vaccinated indicating a high death mortality rate amongst children aged 0 to 5 years old. India is also said to be the country in the world with the largest number of children who never received vaccinations for immunization. Because of the poor health and immunization coverage in India they have trained 250 000 CHWs that will serve as Barefoot doctors. They discovered that out of all the different methods that has been tested in India, the CHW method were found to have the highest impact of increasing the percentage of fully vaccinated children and reducing child mortality rates (Patel & Nowalk, 2009).

Aboubaker, Qazi, Wolfheim, Oyegoke & Bahl (2014) states that CHWs is a remarkable and effective initiative to reduce child mortality. It has shown great progress and led to drastically declining rates of child mortality in many countries. Globally, child mortality deaths of children under five years, have reduced by approximately 50 percent since 1990. 2.8 billion newborns who died in 2013 represent 44 percent of all deaths of children below 5 years of age. Most of these deaths took place during the first 24 hours and were caused by conditions that can easily be prevented or treated. The Barefoot Doctor's initiative of community health workers has been a big part of improving child mortality rates in many countries. The barefoot doctors make five home visits after birth to care for the newborns at home. They counsel families on practices regarding healthy growth and development: illness prevention, vaccines and feeding, etc. They treat child sicknesses among every child in the community under 5 years of age to prevent them from dying of diarrhea, malnutrition, malaria and pneumonia. Community health workers are an imperative step in fighting child mortality and

preventing easily curable and preventable diseases among the rural population (Aboubaker, Qazi, Wolfheim, Oyegoke & Bahl, 2014)

Zachrisen (2020) states that Malawi managed to reduce child mortality rates by 2/3 when applying the Barefoot Doctor's method. Child mortality rates in Malawi has had a significantly decline in just one decade. The child mortality in 1998 was as much as 189/1000, but in 2018 it had sunken to 44/1000. The most significant reason for this drastic change was testing of, and medications provided for, malaria. Malaria is classified as the biggest child killer in Malawi. How has a low-economy country with few doctors and medical personal managed to create this change? At the village levels, these people are called "doctors", but they are not doctors. These are low-educated people in rural areas who has undertaken a crash course in medical training. This training and the work they are doing gives them the right to receive a salary and a pension from the state. Their jobs include using a checklist created by the government for symptoms. This checklist tells them which patients will improve on their own, which patients needs medicine care and which patients must be sent to a hospital. Diarrhea, infections, and malaria are diseases that accounts for 23 percent of the child mortality rate in Malawi. This is also diseases that the "doctors" often treat themselves, which explains why the mortality rate has dropped so drastically. Today, there are 11000 people who have acquired this training and works as "doctors" in rural areas in Malawi. Each "doctor" is responsible for approximately 1000 to 1500 people.
80 percent of Malawi's population live in rural areas. This is usually people with limited resources and limited health knowledge. Because of this, they have no way of acquiring enough money to go to see a doctor in the city or to gain enough medical knowledge themselves. Therefore they often experience higher mortality rates and more sickness in rural areas. This is the reason why primary health care is so vital and why the Barefoot Doctors' model has shown such significant change in Malawi (Zachrisen, 2020).

3.7 OECD evaluation criteria

Relevant – To what degree is the services/intervention relevant? It allows the thesis to evaluate how well the goals and the implementation of the service aligns with the wants and needs of the population. It allows the thesis to determine how useful the objective is and if it is the right thing to do (OECD, 2022).

Impactful – This criterion allows the thesis to determine what difference the objective has made or will make. It is especially important to observe both the negative and positive impacts that the initiative has had on the community, to determine the long-term sustainability of the intervention. Have the social, environmental, and economic aspects improved? This thesis will seek to investigate if the objective creates change that matters and if this change will be sustainable (OECD, 2022).

Effective – The effective criterion allows the thesis to determine to what degree the intervention/service is achieving its goals. The thesis wants to determine if the objective has achieved the planned results and to what degree the results had a positive or negative impact on the community (OECD, 2022).

Sustainable – Will the objective last? The extent to whether the objective will continue. It allows the thesis to determine whether the benefit will last institutionally, financially, technically and motivationally. It should also reflect sustainability in relation to resilience and adaptation skills in complex and dynamic environments (OECD, 2022). The sustainability criteria have close connections to the other criterions used in this paper. Sustainability is for example closely related to effectiveness and impact. To determine if the objective will last, one must first address if the results that have been achieved (effectiveness) and if one can see if any greater effects have been achieved and demonstrated (impact). If one cannot find any support to show that the objective has achieved any significant results, effects, outcomes or impacts one cannot express that there will be any clear benefit to sustain. Hence, it will not be sustainable. Sustainability is the most important criteria as the other criterions are just factors which will help determine whether the objective is sustainable. As was noted earlier, the Barefoot Doctors initiative ended in the 1980s because of structural adjustment programs and failing economies. It is because of this that the sustainability criterion is so imperative. Systems for long-term sustainability must be in place to ensure the continuity of the project even if NGOs leave or the country, community or village experience a social or economic setback. Because of the importance of the sustainability criterion, the thesis will further analyze and describe the four sub criterions that will help determine the relevance, impact, effectiveness and sustainability of the project: institutionally, financially, technically and motivationally (OECD, 2022).

3.8 Sustainability

Institutional - institutions must be in place to ensure the capacity to continue project activities at every level. Moreover, to ensure the project activities' continuity after aid organizations leave the area/country (Utviklingsfondet, 2020). It is the practice where organizations and institutions/associations work together to ensure new norms and practices to achieve sustainable and long-lasting development initiatives. It is important to develop mechanisms for investigating causes and effects of the outcomes of development programs to create ongoing action-learning. Learning and innovation, as well as action and performance assessment, are keys to institutional sustainability because development is an evolving and dynamic process, not a straight line. There are three key factors that are important for institutional sustainability.
Number one; the ability to assess and explore assumptions that lays behind actions.
Number two; creating and establishing accountability for actions between actors and their residents/participants. It is important to agree on responsibilities and roles for each organization, institution, and association to protect the participants/residents.
Number three; being able to characterize the results of the actions, which in turn will enable further possibilities for assessment and learning. To achieve this, it is important to practice open rather than closed systems for sustainable development. Finally, it is important to shift the focus from goal-oriented to action-oriented approaches as the goal is such a small part of the process (Johnson & Wilson, 1999).

Financial - Financial sustainability is the ability to meet the demands of service delivery and financial commitments both now and in the future. It is vital that one can adapt to current policies and to finance the provision of public services now and in the future without causing the dept to continuously increase. Long-term sustainability is measured by three interconnected elements: debt, revenue and service. It is important that institutions can continue to provide the same volume of education, training, goods and services and that they have the resources that will be needed to continue to provide these goods and services in the future without becoming indebted (Galera, Bolívar, Muñoz & Subires, 2016).

Technical – Technological sustainability is described as an organizations/initiatives ability to continue operating its technologies in the present and in the future. The technical sustainability of extension services is reached when the local people/people who are

participating in a program has the resources and technical expertise to continue the program when aid organizations leave (Vacchi, Siligardi, Demaria, Cedillo-González, González-Sánchez, Settembre-Blundo, 2021). How will one ensure that the training provides the trainee with a sufficient level of expertise?

Motivational – Motivation is an internal state that drives, directs and sustain human behavior and choices. Promoting motivation to continue learning and working on sustainable activities is an effective way of promoting sustainable learning. The motivation to act in a certain way as well as the motivation to keep on participating in further similar activities is crucial to make sure that the initiative lasts (Hansmann, 2010). For example, the first farmer teaches the second farmer to conduct sustainable agriculture. How can one provide the LF with enough motivation to teach the FF? How can one provide the LF with enough motivation to continue this work for years? (Utviklingsfondet, 2020). The Barefoot doctors' Model indicates that providing a salary might give more motivation and create continuity of the project.

Chapter four

Method section

This thesis uses both Primary and secondary data and articles to analyze the research question "*How can we sustainably provide services in rural areas in the global south? A critical assessment of Lead Farmers vs. Barefoot Doctors' model for provision of extension services. Examples from Malawi".* This thesis will analyze non-material services, as analyzing material services would mean that the focus would be from a different and more intricate angle. Analyzing material services would demand that we look at corruption, budgets and how effectively money is being used. Whereas analyzing non-material services demands that we look at advice, education and training given to the communities and individuals in the programs, as well as the outcome of these services.

4.0 Sample

The sample consists of the Development Funds extension workers in Malawi who are experts in the field of the Lead Farmers model. The extension workers are responsible for the everyday management of the Lead Farmers project, they assist the lead farmers in education, supervising the progress and giving support when it is needed. The DFs Malawi governments extension workers consist of five individuals who have enough knowledge to consistently answer a questionnaire about the Lead Farmers initiative remotely. For further work, the sample should consist of extension workers, lead farmers and follower farmers to get a broader view of the project and its effectiveness and impact. The process of gathering data from lead farmers and follower farmers would be a time-consuming and expensive process as one would have to travel to Malawi and conduct an interview-based questionnaire individually. Most of the rural population in Malawi is illiterate and would therefore not be able to answer the survey by themselves. Because of the limited data, the conclusion will mostly be based on literature, but the data will be an indication for further work and a supplement to the literature.

4.1 Data collection

The analysis is based on data collected from the questionnaire that was distributed to DFs partners in Malawi. The questionnaire included 36 questions and thesis proceeded with using 28 of those questionees in the data analysis. These 28 questions were further categorized, leaving the dataset with 13 questions. The research methodology used to create the questionnaire was created by reviewing and assessing the different methods of constructing an instrument for data collection found in the book; "Research methodology a step-by-step guide for beginners" (Kumar, 2011). The questionnaire can be found in the appendix. The data was collected in February, and it took approximately three weeks to collect the responses. The data was collected by distributing questionnaires to the extension workers that worked with the Lead Farmers approach Malawi. The thesis will further use the scholars results and statements from the theory section to discuss the positive and negative outcomes of the questionnaire.

4.2 Data analysis

The quantitative data collected through the questionnaire was analyzed by using Excel, R and Python. The respondents' answers were plotted into an excel sheet which was later uploaded to Python. Coding was used to interpret the results and create models in Python. Python provided the thesis with correlations between the variables as well as p-values. It also provided the thesis with negative, neutral, and positive correlations. Model one demonstrates that the spectrum from yellow to blue (yellow -> green -> blue), it shows positive to negative correlations. This model was useful for interpreting the meaning of the correlated values. A positive correlation is the connection between two factors that are inclined to move in the same direction, while a negative correlation indicates that the factors move in different directions. Some specific negative values might demonstrate an error with the respondent's answers. Python was also used to create linear regression models that further demonstrates the relationship of the factors and what they mean. Finally, R was used to create the data for table one and to calculate the mean, SD, max and min of the variable's values. For further work it would be beneficial to collect more data and analyze this data by using multiple linear regression were one uses multiple explanatory variables to predict the outcome of the response variable. This makes the results more reliable but was unfortunately not possible in this data analysis because of the limited number of respondents.

4.3 Choice of methods

The methods used in this thesis were chosen because some of the authors of the secondary literature had contradicting results and statements. Because of this, it was important to do firsthand research and collect primary data to fact check the authors statements. This thesis used a questionnaire to conduct the research to collect primary data. Strengths of a questionnaire is that it is a useful tool for research as it is cost effective, it is easy to distribute, it can be answered remotely, it provides flexibility for the respondents to choose when to complete the questionnaire and it is practical for quantitative analyses. Weaknesses is that one might experience unanswered questions, the respondents might misinterpret some questions, they might understand the questions differently, it might sometimes be hard to analyze some of the questions and the surveyor won't be able to interpret the bodily language and emotions of the respondents.

Because of the extensive knowledge that the extension workers have of the Lead Farmers method and LFs and FFs in Malawi, one might assume that the limited data is somewhat reliable and can be used as an indication for what it might look like with more respondents. What should also be kept in mind is that one cannot disregard the possibility that the respondents might be biased. As the questionnaire only includes individuals that are employees of DF, one could wonder if they might answer more optimistically than the LFs and FFs would as it is their job to oversee the project. They also lack the first-hand experience that LFs and FFs have, as they are not out in the field working with the beneficiaries every day, they are also not the individuals who experience the outcomes and the day-to-day struggles and victories of the program.

A guideline that is often used if one is conducting a questionnaire is that one should multiply the questions by 5 to determine the minimum of responses needed for it to be reliable. This indicates that when one use 28 questions one should have 140 responses, after combining some of the answers, the thesis have a questionnaire of 13 questions, this suggests that there should be a minimum of 65 responses to have a reliable dataset. This insinuates that the dataset of only 5 respondents is too low and are therefore by default not as reliable. This is a weakness of the method, and it impacts the research as the data analysis can no longer be used as a key indicator for the assumptions and the conclusion. Because of this weakness, the data will only be used as an indication for the conclusion, discussion and for further studies.

The thesis uses hypothesis testing, correlation analysis, the calculation of percent, Mean, SD, Min, and Max, it uses P-value and linear regression models. These methods were chosen as hypothesis testing allows the thesis to determine to what extent one have support to implement the Barefoot Doctors' model and to utilize it to supplement the Lead Farmers initiative in Malawi. Correlation analysis is used to determine to what extent the variables have a correlation and how they affect each other. Linear regression models allow visualization of the relationship between the variables and their meaning. The positive, negative, and neutral correlations determine the connections of the variables and the P-value allows determine the statistical significance of the correlation of the variables. Finally, the percent, Mean, SD, Min, and Max is used to provide descriptive descriptions of the variables, to properly demonstrate the respondents' answers.

The weaknesses of using hypothesis testing, correlation analysis and linear regression models are incoherent and/or contradicting results because of limited data. Because of this it is hard to determine whether the answers are correct and for how many individuals these answers are representative for. The extension workers are experts in the field of Lead Farmers and agricultural extension services, but they are not the ones in the field, experiencing the outcomes, the defeats, the triumphs and the daily progress of the initiative and it is therefore hard to determine if their answers would be representative for the LFs and FFs as well.

4.4 Ethical considerations

How can one write about and analyze the respondents' answers without harming them? Project Camelot is an example of data and researchers who were misused. Project Camelot was a military funded project where ethnographers, anthropologists, sociologists etc. were tasked with analyzing the society and culture of numerous countries. The goal of the project was to examine the potential of internal war and rebellions in developing countries. It was supposed to enable the US military to identify actions they could take to prevent and defeat such insurgencies. While, in reality, it was an American intelligence project, where the researchers were exploited as spies so that the military could research the probability of a communist revolution through social science methods in some Latin American countries and to determine whether American interests would be endangered. Later, this project has been labeled as imperialistic and an exploitation of the researchers who were not informed about the true goal of the study (Hunt, 2007). This demonstrates the harm a study can cause the

population of a country, people and communities and to what extent the data one collect can be misused. As a researcher one has a responsibility in relation to the respondents and one need to have in mind that writing about people and communities can have serious political and human consequences. Even with the noblest intentions, quantitative and qualitative research involves a risk. This risk must be minimized.

Conducting an analysis of an ongoing project in a country can be harmful. What will happen if this thesis finds results confirming that the model for agricultural extension services should be improved or changed in some way? This might have huge implications for the lives of the beneficiaries because they would have to learn and adapt to a somewhat new system. What if this system fails? If one is unlucky enough, one could change a model that works to a model that theoretically is supposed to be more effective, impactful, sustainable, and relevant. What happens if this new model is great theoretically, but fails in practice?
What if the analysis indicate that the model should be changed and improved, but the organizations who oversee the objectives fail to do so? This will also have implications for people's lives as the objective will continue to be less effective.

Is it the researcher's responsibility to see to that the findings of a study or research is used properly and for the greater good? Research can be used for both good and bad, it can be harmful and useful simultaneously. Is it then the researcher's responsibility to not research something that can potentially be harmful? Is it not so that anything can be harmful in the wrong hands?

The discussion about what should be researched and what should not be is tricky as almost everything can be used for good and simultaneously for bad. Nonetheless there is certain things one can have in mind when conducting research and publicizing its results.

Some factors to reflect when conducting research:

- The purpose of the survey
- What happens to the information?
- All confidential information must be stored securely
- How much time and effort are required of the informants to respond to the survey?
- Does participating in the survey have negative consequences for the informants?

• Do the informants have the opportunity to withdraw at any time?

How harmful or useful is the search for truth?

Chapter five

Analysis

The data collected from the questionnaires will be analyzed step by step in the next three chapters. The paper will start by providing descriptive explanations for some of the variables, some will be excluded as they have the same explanation as others in the same category. For example, every variable that begins with "prepared for" has the same explanation. It will then proceed with analyzing the models and correlations that was created by using Python, the Python script can be found in the appendix. Some of the results in chapter two will be supplemented with theories from the empirical data, though most of the theory will be included in chapter three as these results are more reliable. Finally, it will analyze the data by studying linear regression models, these models were created after dividing the dataset into categories which allowed the thesis to reduce the variables by 50 percent, thus, making the data more reliable. The models and the outcomes of the last chapter will be based on theories and categories from the empirical data. The results will be considered and explained using theories and statements from the literature review.

5.0 Descriptive explanations of the variables

Improved food accessibility and nutrition security was measured with the following question, *The initiative has allowed for improved food accessibility and nutrition security* The respondents in this survey were asked to answer this question rating the ordinal variable without fractional numbers, the integer rating ranges from 0 (no improvement) to 10 (fully improved), and the standard response rate averaged at 6.6 ± 1.52 (mean, s.d.). The value represents the personal belief in whether food accessibility and nutrition security has improved or not.

Table 1: Descriptive statistics of the variables from the survey. Range = 0-10.

Variable:	Percent	Mean	SD	Min	Max
Improved food accessibility and nutrition security	123456/78910	6.6	1.5	5.0	8.0
Improved food diversification to combat malnutrition	12345678910	7	1.6	5.0	9.0

Improved production and increased yields	1234567/8910	7.4	1.3	6.0	9.0
Improved diversification of livestock	12345678910	6	2.6	2	8
improved capacity to adapt to climate related stresses or challenges	1234567/8910	7.4	1.5	5.0	9.0
improvement in climate related disaster risk reduction	123456/78910	6.4	1.9	4.0	9.0
Improved household economy	12345678910	7	1	6	8
Improved soil quality, fertility, and water storage capacity	1234567/8910	7.4	1.1	6.0	9.0
knowledge of climate science	123456/78910	6.4	1.1	5.0	8.0
knowledge of Agricultural technologies	1234567/8910	7.4	0.5	7.0	8.0
knowledge of Crop rotation	1234567/8910	7.6	1.5	6.0	9.0
knowledge of Intercropping	12345678910	8	1.2	6.0	9.0
Widespread knowledge of Making organic fertilizer	1234567/8910	7.8	0.8	7.0	9.0
Widespread knowledge of Current Impacts of climate change in Malawi	12345678/910	8.4	0.5	8.0	9.0
Widespread knowledge of Future impacts of climate change in Malawi	1234567/8910	7.4	1.5	5.0	9.0
The Lead Farmer initiative has allowed farmers to be more prepared for floods	12345/678910	5.4	1.1	4.0	7.0
The Lead Farmer initiative has allowed farmers to be more prepared for Droughts	123456/78910	6.4	0.9	5.0	7.0
The Lead Farmer initiative has allowed farmers to be more prepared for Pests	12345/678910	5.8	0.5	5.0	6.0
The Lead Farmer initiative has allowed farmers to be more prepared for Extreme rain	123456/78910	6.4	1.4	5.0	8.0
The Lead Farmer initiative has allowed Farmers to be more prepared for Change in seasonality	123456/78910	6.6	0.9	5.0	7.0
The Lead Farmer initiative has allowed farmers to be more prepared for extreme heat	123456/78910	6.2	1.9	5.0	7.0
Some FFs previously stated that it takes too long to experience benefits from the program because their yields have failed to increase, and it takes too long to receive livestock?"	12345/678910	5.4	2.3	2.0	8.0
Some farmers have previously stated that the LF training is too short which in turn might lead to knowledge drain and poorer training of FFs.	12345678910	6.0	1.4	4.0	7.0
Some LFs has previously stated that they are being overworked as they have too many Follower farmers each.	12345/678910	5.4	2.4	2.0	8.0
would we experience that LFs motivation to work would be improved if they obtained a salary or compensation like they do in the Barefoot Doctors' initiative?	123456/78910	6.2	2.7	2.0	8.0
Some community members have previously stated that the selection process to be an LF and to gain livestock at an early stage is biased. They believe that progressive or elite farmers has been picked before other farmers.	12345/678910	5.6	1.1	4.0	7.0
Will the objective last when the Development fund leaves?	123456/78910	6.2	1.6	5.0	8.0
Gender		0.4	0.5	0.0	1.0
	Male 60%				
	Female 40%				

N: 5

Respondents in this survey was asked to rate the ordinal variable without fractional numbers on the question: *The initiative allows for improved capacity to adapt to climate related stresses or challenges*. The integer ratings range from 0 (no improvement) to 10 (fully improved), and the standard response rate averaged at 7.4 ± 1.52 (mean, s.d.). The value

represents the personal belief in whether the capacity to adapt to climate related stresses or challenges has improved.

Improved knowledge about agricultural technologies was measured with the following question, *People in the organization has a widespread knowledge of Agricultural technologies and would be able to give a logical and reflective definition of this term*. The respondents in this survey were asked to answer this question rating the ordinal variable without fractional numbers, the integer rating ranges from 0 (no improvement) to 10 (fully improved), and the standard response rate averaged at 7.4 ± 0.55 (mean, s.d.). The value represents the personal belief in whether knowledge about agricultural technologies has improved or not.

Improved knowledge about current impacts of climate change in Malawi was measured with the following question, *People in the organization have a widespread knowledge of current impacts of climate change in Malawi and would be able to give a logical and reflective definition of this term*. The respondents in this survey were asked to answer this question rating the ordinal variable without fractional numbers, the integer rating ranges from 0 (no improvement) to 10 (fully improved), and the standard response rate averaged at 8.4 ± 0.55 (mean, s.d.). The value represents the personal belief in whether knowledge about current impacts of climate change in Malawi has improved or not.

Improved preparedness for floods was measured with the following question, *The Lead Farmer initiative has allowed farmers to be more prepared for floods*. The respondents in this survey were asked to answer this question rating the ordinal variable without fractional numbers, the integer rating ranges from 0 (no improvement) to 10 (fully improved), and the standard response rate averaged at 8.4 ± 0.55 (mean, s.d.). The value represents the personal belief in whether preparedness for floods has improved or not.

LFs training was measured with the following question, *some farmers have previously stated that the LF training is too short which in turn might lead to knowledge drain and poorer training of FFs*. The respondents in this survey were asked to answer this question rating the ordinal variable without fractional numbers, the integer rating ranges from 0 (not agree) to 10 (agree), and the standard response rate averaged at 6.0 ± 1.41 (mean, s.d.). The value represents the personal belief in whether the LF training is too short or not.

5.1 Analysis of models and data

This chapter will revise and explain the statistically significant correlated values. All values will be explained to refrain from being biased and choosing only values that align with the alternative hypothesis, but only some of the values will be demonstrated in this chapter. The additional values can be found in the appendix, below the *Explanation of the correlated values* section. The variables in this chapter has no proven causation, but they have a relationship to each other as they are correlated. It is important that the OECD criterions relevant, impactful and effective is reached to achieve long-term sustainability of agricultural extension services. The next two chapters will evaluate the correlated and the causation variables and their long-term sustainability by also evaluating their relationship to the OECD criterions.

The purpose of this thesis is to determine whether one can use the Barefoot Doctors' model to supplement the Lead Farmers initiative in Malawi to provide sustainable services in the global south. To test this notion, the thesis will use hypothesis testing, the null hypothesis is:

H_0 = The variables do not provide any support for the Barefoot Doctor's model

While the alternative hypothesis is:

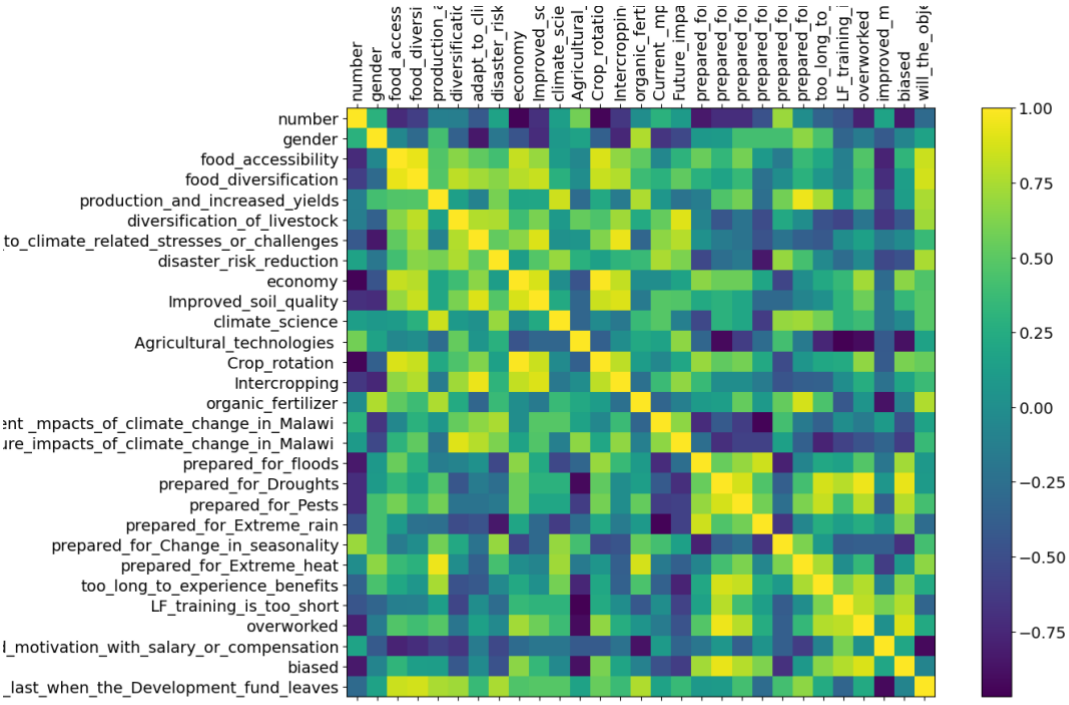
H_a = The variables provide some support for the Barefoot Doctor's model

The null hypothesis suggests that the variables being studied has no correlation and they do not affect each other. The null hypothesis states that whatever the thesis is trying to prove is false. If one cannot somewhat reject the null hypothesis, it means that there is less evidence to support implementing the Barefoot Doctor's model and to utilize it to supplement the Lead Farmers initiative in Malawi (Kumar, 2011).

The alternative hypothesis states that the variables have a correlation and that they do affect each other. One can then use these variables to somewhat reject the null hypothesis. If one can somewhat reject the null hypothesis, it means that one has evidence to support implementing the Barefoot Doctor's model and to utilize it to supplement the Lead Farmers initiative in Malawi (Kumar, 2011).

A correlation can be negative, neutral, and positive. A neutral correlation indicates that the variables have no connections, they are unrelated. Unrelated variables cannot affect each other as they change in the same direction, leading them to have no relationship. A positive correlation is the connection between two variables that are inclined to move in the same direction. For example, when one variable decreases the other also tends to decrease, and if one increases the other tend to increase. A negative correlation indicates that the variables move in different directions, if one increases, the other decreases. For example, if X gains value, Y lose value (DeSoto & Roediger, 2014).

Figure 1, Correlation matrix. Depicting positive, negative, and neutral correlations of the variables.



This model demonstrates whether there is a positive or negative correlation. The dark blue parts of the column are negative, while the yellow side is positive and the middle is neutral. This model will be used to determine whether the correlation has an effect and then subsequently check the tables below to determine whether there is a statistical significance by checking for p-values.

Let's look at *Food accessibility* and *Food diversification*. *Food accessibility* has a positive correlation to *Food diversification*. This suggest that both variables move in tandem and when

Food accessibility increases, *Food diversification* simultaneously increases. This indicates that the impact criterion is more likely to be met as the social, environmental and economic aspect are more likely to improve. Finally the p-value will demonstrate the significance of the values. The p-value is 0.018*, making it statistically significant.

A p-value is the probability of rejecting or failing to reject the null hypothesis. A P-value witnesses the strengths of the evidence against the null hypothesis, this indicates that the smaller the P-value, the stronger the evidence against the null hypothesis is This thesis will allow p-values up to 0.1* to be statistically significant because of the limited data. A P-value of 0.1 suggests that one can observe weak evidence or a trend, a P-value of 0.05 indicates moderate evidence and a P-value of 0.01 indicate strong evidence against the null hypothesis. (Thiese, Ronna & Ott, 2016).
A limit for the p-value had to be set and upheld to reduce any prejudices in the selection of data. It is easy to choose data that would support the H_a premise and dismiss data that would support the H_0 premise. To be as objective as possible, the thesis will include all data below the significance level of 0.1*.

The correlation between the variables *Crop rotation* and *Food accessibility* has a positive effect. This correlation implies that both variables move in tandem and when *Crop rotation* increases, *Food accessibility* simultaneously increases. The correlation between these two variables has a P-value of 0.042* making them statistically significant. Crop rotation is the practice of planting different kinds of crops sequentially to boost resilience, to improve soil health, to optimize nutrients in the soil and to combat occurring pests and diseases (Andersen, 2019). This practice ensures increased food accessibility as the soil is healthier and contains more nutrients leading to bigger and better yields. This practice also ensures climate and disease resilience as the soil stays healthy, compared to for example traditional techniques where one uses newly burned vegetation areas used for agriculture. This implies that when farmers have knowledge of crop rotation and experience improved food accessibility the OECD evaluation criterions impact, effectiveness, relevance and sustainability is more likely to be met. These traditional agricultural techniques where farmers cultivate and use the topsoil until it is depleted is a very unsustainable way of farming, which may lead to food shortage and long-term damaged soil. Therefore, by using new practices like crop rotation, one ensures healthy soil quality and constant food accessibility.

The correlation between the variables *Crop rotation* and *Economy* has a positive effect. This correlation indicates that both variables move sequentially, when *Crop rotation* increases, *Economy* simultaneously increases. The correlation between these two variables has a P-value of 0.001** making them statistically significant. This demonstrates that through learning and adopting agricultural technologies like crop rotation, one will also eventually experience an increased household economy and achieve the OECD criteria positive impacts on the community, *"Today I sing a different song. I am no longer a destitute widow failing to feed herself and her family. Through the project I have managed to become food and income secure. Currently, I have started to build a house for rent at Mpamba Trading Centre on a plot which my husband bought before his passing"* – change story from a participant in the DF Lead Farmers project in Malawi (Utviklingsfondet, 2020). One should keep in mind that these statements might be biased as the Development Fund collected change stories and not anonymous statements about the sustainability and effectiveness of the project.

The correlation between *Crop rotation* and *Intercropping* has a positive effect. This correlation indicates that both variables move in sequence, when *Crop rotation* increases, *Intercropping* simultaneously increases. Crop rotation leads to better soil qualities and therefore, better conditions for intercropping. The correlation between these two variables has a P-value of 0.098* making them statistically significant. Andersen indicates that crop rotation and intercropping has contributed to better nutrition and that food insecurity has decreased. Intercropping is the practice where one plants multiple different crops in a field and crop rotation is the practice of planting different kinds of crops sequentially to boost resilience, to improve soil health, to optimize nutrients detected in the soil and to combat occurring pests and diseases (Andersen, 2019). An example of intercropping is when one plants both beans and maize, beans release nitrogen into the soil which is necessary to enhance the maize production. "*From the same land (0.6ha) we used to harvest 300kgs of maize before the project, we harvested 1100Kg of maize after practicing CA, pit planting and manure application. My family has changed in terms of nutritional status – we can diversify our diet even in the critical months of food shortage".* – change story from a participant in the DF Lead Farmers project in Malawi (Utviklingsfondet,2020). Intercropping is a cheaper and more effective way of increasing food diversification and surplus as the crops give nutrients to each other (eliminating the needs of store-bought nutrients). In addition, the farmers have multiple different crops making them more resistant to different weather conditions (Andersen, 2019).

5.1.1 Negative correlations

The correlation between the variables *Adapt to climate related stresses and challenges* and *Gender* has a negative effect. Negative values implies that the variables move in opposite directions. Women believe that people in the Lead Farmers initiative are less likely to be able to adapt to climate related stresses and challenges, therefore the value decrease, while men believe that people in the Lead Farmers initiative are likely to be able to adapt to climate related stresses and challenges, therefore the value increase. The correlation between these two variables has a P-value of 0.073* making them statistically significant.

The correlation between *Overworked* and *Agricultural technologies* has a negative effect. This negative correlation suggests that when one increase, the other decrease. This indicates that if the overworked variable increase, the agricultural variable will decrease and vice versa. To achieve the OECD evaluation criterions relevant, effective, impactful and sustainable one needs to ensure that LFs are not overworked and that they can provide good quality training of agricultural technologies. The correlation between these two variables has a P-value of 0.032* making them statistically significant.

The correlation between *Organic fertilizer* and *Improved motivation with a salary* has a negative effect. This negative correlation suggests that when one increase, the other decrease. This indicates that if the *Organic fertilizer* variable increase, the *Improved motivation with a salary* will decrease and vice versa. The correlation between these two variables has a P-value of 0.056* making them statistically significant.

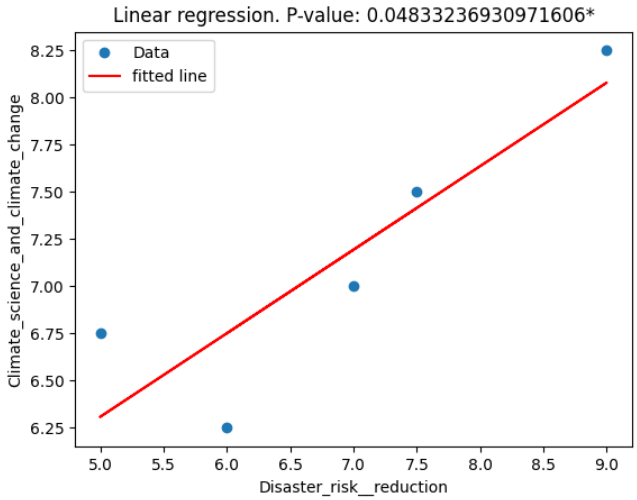
The correlation between *LF training is too short* and *Agricultural technologies* has a negative effect. This negative correlation means that if *LF training is too short* variable increase, the *agricultural technologies* variable will decrease and vice versa. To achieve the OECD evaluation criterions relevant, effective, impactful and sustainable one needs to ensure that the lead farmer education is comprehensive enough for them to be able to provide good quality training of agricultural technologies. The correlation between these two variables has a P-value of 0.007** making them very statistically significant.

5.2 Linear regression

For the next models, the dataset was divided into categories to make it more reliable. For example, every category that begins with *prepared for* has now been created as one and is called *prepared for weather changes*. This chapter corresponds with the previous chapter, but the data is now categorized, the variables are causation variables which indicates that there is a cause-and-effect relationship between them, in addition, the relationship is visualized with models. The categorized dataset exists of 12 variables, excluding gender as it was no longer necessary. This method ensures that the data is more reliable even if someone misunderstood a question or answered it incorrectly as all similar questions were categorized. Linear models are advantageous because of its linearity and straightforward assessment process, these models describe continuous response variables as a function of one or multiple predictor variables. The linear regression models can assist in apprehending and predicting the behavior of complex domains and systems, such as agricultural extension services (Aalen, 1989).

5.2.1 Values that reveal Sustainability and Relevance of the project

Model 1, Linear regression model of the categorized survey questions.



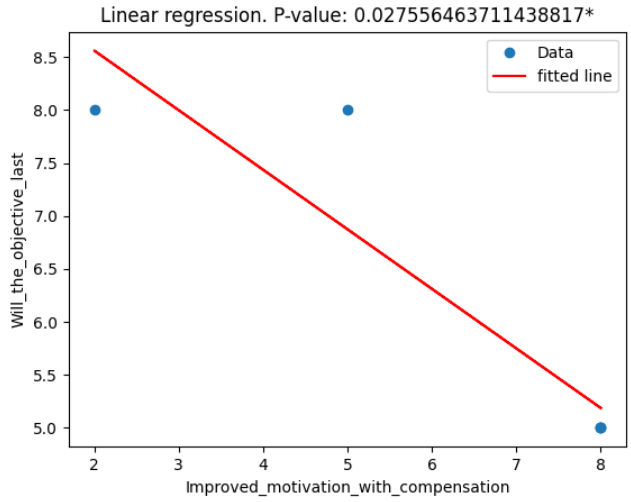
$$Y = a + bX$$

$$Y = 4.09 + 0.44X$$

The model aims to analyze the conditions necessary to solve the problem statement, *How can we sustainably provide services in rural areas in the global south?* X is the explanatory variable: *Disaster risk reduction* and Y is the dependent variable: *Climate science and climate change*. The slope of the line is b, and a is the intercept which is the value of y when x = 0.

Model 1 has a P-value of 0.048* making it statistically significant and it has an R-value of 0.88. Standard error: 0.14. This model states that when farmers can practice- and have knowledge of disaster risk reduction techniques they also have more knowledge of climate science and climate change in Malawi. The agricultural techniques used in the Lead Farmers method is said to be mitigating the effects of climate change, it is therefore imperative that LFs and FFs have a lot of knowledge of current and future impacts of climate change in Malawi (Andersen, 2019). Having knowledge of climate change in Malawi will help them determine what disaster risk reduction measures they should take and what to focus on. These variables correlate with the OECD criteria relevance because they are useful in assisting the rural population with their goals and needs. Having a considerable amount of knowledge of current and future impacts of climate change in Malawi allows the farmers to design and implement disaster risk reduction technologies that are relevant in terms of their needs. This model implies that quality training and farmers ability to conduct their own needs assessments are crucial if they are to practice effective disaster risk reduction techniques. This indicates that the variables provide some support for the Barefoot Doctor's model and that one should seek to implement the educational and relevance elements of the Barefoot Doctors model.

Model 2, Linear regression model of the categorized survey questions.



$$Y = a + bX$$

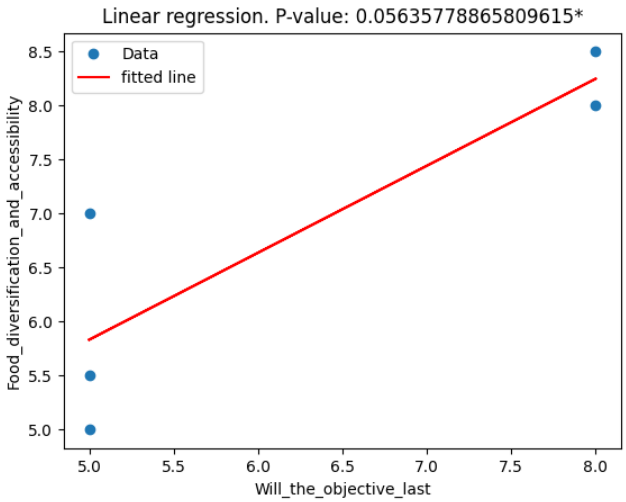
$$Y = 9.69 + 0.56X$$

The model aims to analyze the conditions necessary to solve the problem statement, *How can we sustainably provide services in rural areas in the global south*. X is the explanatory variable: *LFs will experience an improved motivation with a salary or compensation* and Y is the dependent variable: *Will the objective last when the Development Fund leaves?* The slope of the line is b, and a is the intercept which is the value of y when x = 0.

Model 2 has a P-value of 0.028* making it statistically significant and it has an R-value of 0.92. Standard error: 0.93. The model indicates that people who believe that the objective will last when the Development Fund leaves also believes that LFs motivation to work would not improve with a salary or compensation. This implies that to reach the OECD criteria sustainability, one should not focus on salaries and compensation. This result correlates with the statements of some of the authors, volunteering is seen as an altruistic activity and the lead farmers get their motivation by producing a feeling of accomplishment and self-worth. It might also be because the lead farmers acquire some sort of compensation through obtaining knowledge to improve their own farms, early access to new technologies and because they can take part in income generating activities at an early stage (Tchuwa & Simpson, 2015). This also correlates with the statement that LFs might already be seen as another “class” than

the FFs and if LFs were to gain a salary the perception of progressive or elite farmers being cherry-picked before other farmers and therefore obtained privileges because of their status might be enhanced (Ragasa, 2019). This model shows no support for the Barefoot Doctors model as implementing a salary would most likely damage the project and create more distrust and jealousy among the farmers.

Model 3, Linear regression model of the categorized survey questions.



$$Y = a + bX$$

$$Y = 1.81 + 0.81X$$

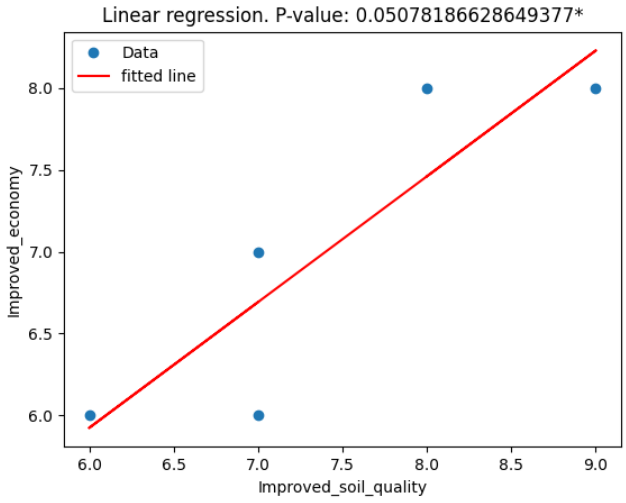
The model aims to analyze the conditions necessary to solve the problem statement, *How can we sustainably provide services in rural areas in the global south*. X is the explanatory variable: *Will the objective last when the Development Fund leaves?* and Y is the dependent variable: *Food diversification and accessibility*. The slope of the line is b, and a is the intercept which is the value of y when x = 0.

Model 3 has a P-value of 0.056* making it statistically significant and it has an R-value of 0.87. Standard error: 0.27. This model indicates that the objective is more likely to last if farmers experience increased food diversification and accessibility. This demonstrates that it is important to make sure that the OECD evaluation criteria are met, and that one focuses on the sustainability criteria which determines the extent to whether the objective will last. The

variables imply that to reach a long-lasting sustainable project, one needs to also focus on the relevance of the implementations of the service with the needs of the population. This model suggests that improved food diversification and accessibility is a need that needs to be met to ensure long-term sustainability (OECD, 2022). It is important to ensure that FFs feel like they experience significant change from the program. Some young people fall out of the program as it would take too many years for them to see or experience any significant change. For example, it might take many years from the first farmer gaining livestock to the pass on system has generated enough offspring to give to the last farmer. Thus, the last farmer might have to wait for many years before he/she gains livestock. They must experience other farmers and households' lives improve as they gain benefits from extra livestock, bigger yields, and more diversified crops while they themselves know that it might take one, five or even ten years before they would gain these benefits. This is quite discouraging as they are in the program but can't experience the positive effects of it. This might make them drop out of the program as they can't see any significant change happening any time soon (Ragasa, 2019).

5.2.2 Values that reveal Impacts of the project

Model 4, Linear regression model of the categorized survey questions.



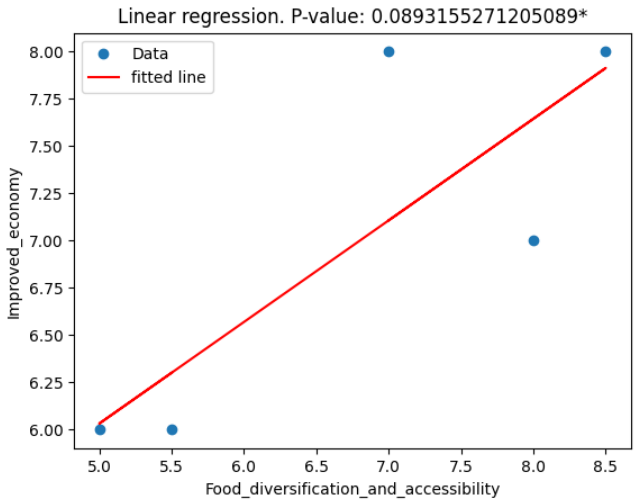
$$Y = a + bX$$

$$Y = 1.31 + 0.77X$$

The model aims to analyze the conditions necessary to solve the problem statement, *How can we sustainably provide services in rural areas in the global south*. X is the explanatory variable: *Improved soil quality* and Y is the dependent variable: *Improved economy*. The slope of the line is b, and a is the intercept which is the value of y when x = 0.

Model 4 has a P-value of 0.051* making it statistically significant and it has an R-value of 0.88. Standard error: 1.82. This model indicates that when soil quality improves, the economy will improve with it. The agricultural technologies taught in this model is supposed to allow farmers to improving their soil quality by teaching them new and sustainable cultivation techniques. It allows them to learn agricultural techniques like, crop diversification through rotation or intercropping, minimum soil disturbance and crop residue retention (Fisher, Holden, Thierfelder & Katengeza, 2018). This is all techniques that creates better soil quality and with better soil quality one will experience bigger and better crops which in turn might lead to a surplus and an improved economy (Andersen, 2019). This suggests that when soil quality improves, the social, environmental and economic aspects of the OECD criterion impactful are also improving. This demonstrates that the objective has made a difference on the community.

Model 5, Linear regression model of the categorized survey questions.



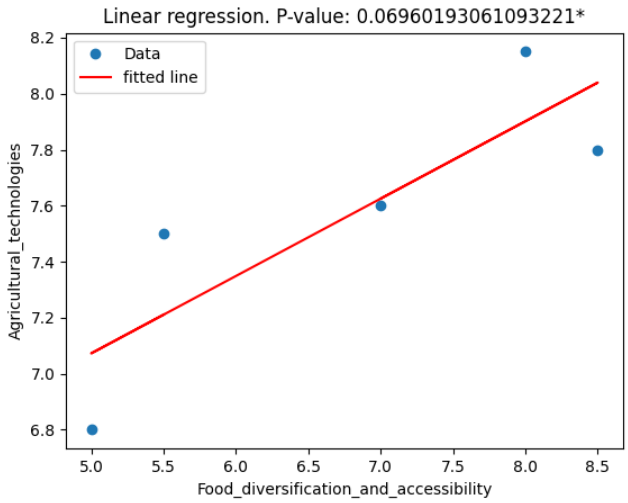
$$Y = a + bX$$

$$Y = 3.34 + 0.54X$$

The model aims to analyze the conditions necessary to solve the problem statement, *How can we sustainably provide services in rural areas in the global south*. X is the explanatory variable: *Food diversification and accessibility* and Y is the dependent variable: *Improved economy*. The slope of the line is b, and a is the intercept which is the value of y when x = 0.

Model 5 has a P-value of 0.089* making it statistically significant and it has an R-value of 0.82. Standard error: 0.22. The linear regression model suggests that increased food accessibility and food diversification leads to an improved economy. As was indicated earlier in the paper, when rural farmers and individuals experience an increased food diversification and food accessibility, they will also experience a surplus of food. This surplus might allow them to gain extra income, which they can later use to further improve their well-being (Utviklingsfondet, 2022). It suggests that the OECD impact criterion is an important step in reaching long-term sustainability. When farmers experience increased food accessibility and food diversification they will also experience an improved economy, this suggests that the objective has made a difference and impact on the community.

Model 6, Linear regression model of the categorized survey questions.



$$Y = a + bX$$

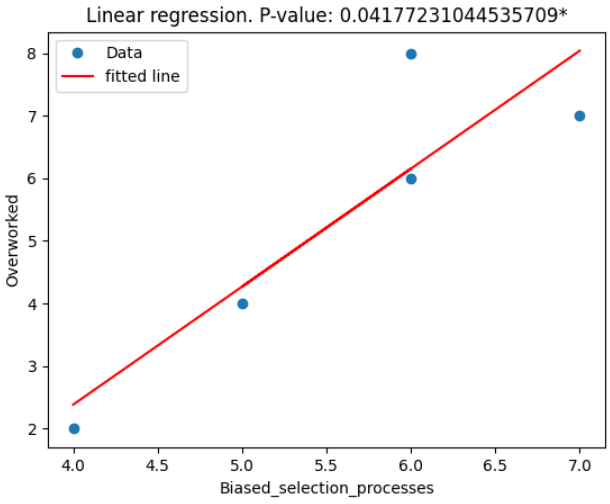
$$Y = 5.69 + 0.28X$$

The model aims to analyze the conditions necessary to solve the problem statement, *How can we sustainably provide services in rural areas in the global south*. X is the explanatory variable: *Food diversification and accessibility* and Y is the dependent variable: *Knowledge of agricultural technologies*. The slope of the line is b, and a is the intercept which is the value of y when x = 0.

Model 6 has a P-value of 0.07* making it statistically significant and it has an R-value of 0.85. Standard error: 0.1. This model indicates that the more food diversification and accessibility farmers experience, the better knowledge they have of agricultural technologies. This demonstrates the importance of extensive knowledge of agricultural technologies and the importance of quality training in those techniques. Simpson & Tchuwa states that when they asked the respondents about the topics, they were most likely to discuss during the training, only about a third of them mentioned farming methods and agricultural technologies (Tchuwa & Simpson, 2015). It is therefore important that the lead farmers regularly attend training programs that are focused on increasing the knowledge about farming methods and agricultural technologies to meet the OECD criterion Impact. As the goal of the program is to combat rural poverty and create climate resilience by focusing on agriculture in the rural population.

5.2.3 Values that reveal Effectiveness of the project

Model 7, Linear regression model of the categorized survey questions.



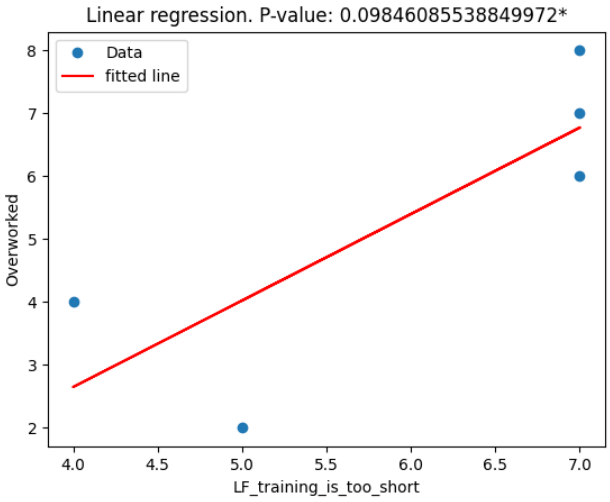
$$Y = a + bX$$

$$Y = 5.15 + 1.89X$$

The model aims to analyze the conditions necessary to solve the problem statement, *How can we sustainably provide services in rural areas in the global south.* X is the explanatory variable: *Biased selection processes* and Y is the dependent variable: *Overworked*. The slope of the line is b, and a is the intercept which is the value of y when x = 0.

Model 7 has a P-value of 0.042* making it statistically significant and it has an R-value of 0.89. Standard error: 0.06. This model indicates that when the selection process to be an LF is biased, LFs often feel more overworked. Fisher, Holden, Thierfelder & Katengeza (2018) states that lead farmers and follower farmers have heterophilous relationships, this might indicate that it is harder for LFs to encourage adaptation of agricultural techniques as they lack some of the trust that exists between FF to FF (Fisher, Holden, Thierfelder & Katengeza, 2018). Some FFs have stated that they feel like LFs are privileged farmers who have been cherry-picked to become LFs and that LFs feel superior to the rest of the village *"Mostly people try to show them as failures deliberately because of jealousy. To add on that, most people don't attend the meetings as called by a lead farmer." – Male respondent, Mangochi, remote community* (Ragasa, 2019). Because of these issues, LFs will have to work harder and longer to gain trust and to be able to encourage and promote adoption of agricultural techniques. This might lead to LFs being overworked and therefore the OECD criterion effectiveness will not be reached.

Model 8, Linear regression model of the categorized survey questions.



$$Y = a + bX$$

$$Y = 2.85 + 1.38X$$

The model aims to analyze the conditions necessary to solve the problem statement, *How can we sustainably provide services in rural areas in the global south.* X is the explanatory variable: *LF training is too short*, and Y is the dependent variable: *Overworked*. The slope of the line is b, and a is the intercept which is the value of y when x = 0.

Model 8 has a P-value of 0.099* making it statistically significant and it has an R-value of 0.81. Standard error: 0.58. This model indicates that when LF training is too short, LFs are also more often overworked. Tchuwa & Simpson found that 45 percent of the respondents stated that the initial training to become an LF lasted for just one day, 19 percent answered that their training lasted for two-three days and 27 percent stated that their training lasted for more than five days (Tchuwa & Simpson, 2015). All the scholars in the literature review agrees that LF training should be longer and more comprehensive, for example, Andersen believes that LF trainings should be longer and more extensive. She recommends starting with 15 days of training which is cut in three parts with a few days break between each part, allowing the LFs to reflect and practice what they have learned. She also believes that there should be refreshment trainings every year. Ragasa states that LFs were not effective and that they performed at a substandard level, hence, they are failing to properly accomplish their

tasks (Ragasa, 2019). The quality of LF training is very important if one wants to meet the OECD evaluation criterion effectiveness, limited LF training has a somewhat negative effect on the initiative as LFs are unable to properly execute their tasks. To ensure a long lasting and sustainable program, one needs to ensure that the OECD evaluation criterions are met. This indicates that the variables provide some support for the Barefoot Doctor's and that the longer education and continuous in-service trainings of the Barefoot Doctors model should be implemented to the Lead Farmers model.

Chapter six

Discussion

How can we sustainably provide services in rural areas in the global south? A critical assessment of Lead Farmers vs. Barefoot Doctors' model for provisional extension services. Examples from Malawi.

This thesis has discussed literature from both the Lead Farmers model and the Barefoot Doctors model to assess if one can use the positive results experienced from the Barefoot Doctors initiative to enhance the Lead Farmers model. The thesis has also studied theoretical frameworks that needs to be in place to create a long-lasting and efficient program for agricultural extension services. The different theories and findings provided by the scholars will be discussed and linked to the OECD criterions as well as the sustainability criterions, institutional, financial, technical, and motivational. The causes and effects of the outcomes of the Lead Farmers and Barefoot Doctors' model will be investigated to create ongoing action-learning to achieve the best possible results and to determine the best possible methods to achieve these results.

During the 21st century agricultural extension services shifted its focus from a top-down approach to a bottom-up approach. This new approach revolves around the belief that extension services are more efficient if one targets farmers felt needs. Farmers should themselves be allowed to decide what efforts should be implemented and utilized. Because of this, it is worrying to see the results of Tchuwa & Simpsons analysis, they found that only 36 percent of farmers conducted their own needs assessments (Tchuwa & Simpson, 2015). To ensure long-term sustainability of the objective, one must make sure that the needs of the population is met. Sustainability allows the thesis to determine to what degree the benefit will last institutionally, financially, technically, and motivationally (OECD, 2022). If one fails to meet the needs of the population and instead force change upon others, one is already moving in an unsustainable direction. Long-term sustainability will more likely be achieved if farmers can themselves decide what measures they want to take, what needs they want met and what support they want to receive.

The intervention is useful socially, environmentally and to reach the SDGs. Because of the changing climate and rising temperatures, it is necessary to develop new and sustainable agricultural technologies that will make it easier to grow crops, achieve bigger yields and raise livestock in unpredictable weather conditions. Agricultural extension services were created to meet the needs of people to create resilience and adaptation skills to survive the changing climate. The intervention focuses on sustainable and climate friendly agricultural technologies that will assist in enhancing life-quality of the rural poor. One of the aspirations of the intervention is to avoid the environmentalist paradox. The environmentalist paradox is the belief that environmental degradation will lead to increased human suffering; therefore, it is important to focus on fixing the problems of today by focusing on sustainable means of reaching the goal. Extension services could encourage rural farmers to use unsustainable, but effective agricultural technologies to enhance their crops and farms. Utilizing unsustainable agricultural technologies would only lead to the environmentalist paradox, hence worse conditions for themselves and future generations.

6.0 The OECD evaluation criterions relationship to the findings

6.0.1 Relevance

The relevance criterion seeks to assess the extent to which the intervention addresses and meets the beneficiaries needs and priorities. The needs of the beneficiaries must be addressed in contexts that includes economic, environmental, social and resources. It is also important to assess the relevance over time to undergo on-going action learning and assessments of the program. It is important that the intervention adjusts the program over time to meet the evolving needs of the beneficiaries and to ensure the effectiveness, impact and sustainability of the program (OECD, 2022).

The Barefoot Doctors initiative have been successful in meeting the needs of the beneficiaries, for example, the most significant reason for child mortality in Malawi is malaria, diarrhea and infections. Because of this, the Barefoot Doctors initiative chose to focus on educating the barefoot doctors in these diseases and to provide them with checklists to assist them in the evaluation and examination of patients. By focusing on these diseases, the initiative managed to establish a high degree of relevance (Zachrisen, 2020). The Lead

Farmers initiative on the other hand seems to have had more contradicting results when it comes to meeting the beneficiaries needs and priorities as only a limited percentage of farmers conducted their own needs assessment. Some farmers have stated that it takes too long to experience benefits from the program and some have mentioned that they are not provided with the tools and means that are necessary to participate in the program.

This is demonstrated by the claim that some young people fall out of the program as it would take too many years for them to see or experience any significant change. In practice this would imply that they have learned about a method and experienced others positive outcomes from this method. Nonetheless, they will not be able to practice this method during their lifetime or for many years as it takes too long to gain the necessary products to start the process, e.g., the pass on system takes too long, they can't afford seeds and/or the intervention are not offering enough start up packages etc. (Ragasa, 2019). It is imperative to ensure that people will experience benefits from the program in a reasonable amount of time to ensure relevance. Relevance is the evaluation of the extent to which an intervention addresses beneficiaries' needs and priorities, therefore, it is imperative that those needs are heard (OECD, 2022).
The Lead Farmers initiative have been experiencing some occurring issue of livestock handling, but by addressing these issues one can see the immense potential of livestock and the pass on system in rural areas. Mulwafu & Krishnankutty express the necessity of extensive livestock training of the lead farmers and the importance of consistent supervision of the project (Mulwafu & Krishnankutty, 2012).

In addition, only 54 percent reported that they received materials for demonstrations, such as seeds, implements and fertilizers. This is materials that are necessary for farmers to participate in the intervention and for lead farmers to demonstrate the agricultural technologies necessary for the follower farmers to experience benefits from the program (Tchuwa & Simpson, 2015). Model 6 indicates that the more food diversification and accessibility farmers experience, the better knowledge they have of agricultural technologies. This suggests that materials for demonstrations are imperative as they are necessary to teach others new agricultural technologies. This demonstrates that the Lead Farmers program sometimes neglects to meet the beneficiaries needs and priorities.

The Lead Farmers initiative has proven to have a positive effect and relevance in Malawi as well, the initiative has helped many farmers increase their food diversification and food availability as well as it has improved some farmers household economy. The Lead Farmers initiative is a model that mobilizes communities, generates knowledge around climate change and raises awareness and collaboration among different stakeholders. It allows farmers to gain knowledge of disaster risk reduction to help them prepare for floods, pests, droughts, and heavy rain etc. The program works towards ensuring that farmers gain knowledge about current and future impacts of climate change in Malawi. As model 1 states, when farmers can practice- and have knowledge of disaster risk reduction techniques they also have more knowledge of climate science and climate change in Malawi. The agricultural techniques used in the Lead Farmers method is said to be mitigating the effects of climate change, because of this, it is crucial that farmers have a lot of knowledge of impacts of climate change in Malawi. This will allow the farmers to determine and evaluate what precautions to take and what agricultural technologies they need to learn and want to adopt.

The Lead Farmers model has both its limitations and successes when it comes to meeting farmers felt needs. The Barefoot Doctors model on the other hand has been successful in its adoption of technologies, training and knowledge that will meet the needs of the population. This thesis will further seek to investigate the needs of the farmers, the quality of the intervention and its long-term sustainability by assessing the OECD criterions impactful, effective and sustainable.

6.0.2 Impactful

The impact criterion seeks to investigate the significance of the intervention and the higher-level results it strives to achieve. The impact criterion also seeks to determine if the intervention has positive or negative unintended effects (OECD, 2022).

There are three key elements for an impactful and effective Lead Farmers program, quality of LFs, the adoption behavior of LFs and the regular training of LFs. An issue stated by Ragasa is the unintended effect of farmers receiving lead farmer trainings without sharing what they have learned with follower farmers. Some farmers use what they have learned to practice it in their own fields creating distrust from the rest of the farmers (Ragasa, 2019). Lead Farmers need to be well-respected in their village, they need to be hard-working, they must be seen as

peer-farmers, they must enjoy helping others and they need to be an expert in the domain of agricultural technologies. It is important to choose LFs that enjoy working with and helping others to create a sustainable program that ensures the continuity of the objective (Tchuwa & Simpson, 2015).

Because lead farmers and follower farmers have a heterophilous relationships the impact of adoption behavior is less effective. The relationship between lead farmers and follower farmers are more effective in creating awareness of new agricultural technologies, which is forcing them to act more as extension workers. While the relationship between follower farmers are homophilous, like the barefoot doctor's relationship to their patients. Individuals with a homophilious relationship derives from the same socio-economic background and have the same resource access. This relationship generates more trust between farmers and less jealousy, allowing them to prompt other farmers to adopt new innovations and technologies (Fisher, Holden, Thierfelder & Katengeza, 2018).

Lastly, Tchuwa & Simpson found in their analysis that 45 percent of the respondents answered that their training lasted for just one day, 19 percent stated that it lasted for two to three days and 27 percent stated that it lasted for more than five days (Tchuwa & Simpson, 2015). Model 8 suggests that when LF training is too short, LFs are also more often overworked. Inadequate lead farmers training results in unintended negative effects of the objective, leading it to be less impactful and effective. Insufficient education can result in knowledge drain, distrust and poor-quality training of follower farmer. Insufficient training leads the objective to be less impactful because it will lack the higher-level results one can experience from the Barefoot Doctors model. The Barefoot Doctors model has managed to reduce child mortality rates in Malawi by 2/3. This model has achieved highly impactful results which might derive from the six months education that they undertake, this education is more extensive and thorough than the LF education (Zachrisen, 2020). Barefoot doctors also managed to effectively utilize their time, by using 1/3 on gardening, farming and health work. This leaves time for them to effectively achieve all their tasks. The Barefoot doctors model also leaves room for further education and continued in-service training to prevent issues of knowledge drain and incomprehensive medical help to the rural population (Haklev, 2005).

6.0.3 Effective

The effectiveness criterion helps understanding the extent to which an intervention is achieving or has achieved its goals. When evaluation effectiveness one should explore the achievement and/or the lack of achievements of the various goals and results of the intervention (OECD, 2022).

The effectiveness of the LF selection process has proven to be somewhat limited. Malawi has a long history of supporting privileged farmers to become advisors with subsidies and inputs (Malindi, 2015). This issue is yet to be resolved as some farmers still believe that the selection process to become an LF and to benefit from the program at an early stage is biased. The literature review found that lead farmers often have more resources, bigger farms and are wealthier than other farmers, because of this they are not seen as peer-farmers (Fisher, Holden, Thierfelder & Katengeza, 2018). Model 7 suggests that when the selection process to be an LF is biased, LFs often feel overworked. When the selection process is biased, LFs will have to work harder and longer to gain trust and to be able to encourage and promote adoption of agricultural techniques. This indicates that the intervention is not achieving its intended results and that the management of the process is somewhat ineffective. While the Barefoot Doctors model on the other hand is described as an intervention where the doctors and farmers have a high degree of homophily (the same socio-economic background). This might suggest that the barefoot doctors derive from the same socio-economic background as the other farmers and because of that they had access to the same number of resources, allowing them to be perceived as peer-farmers (Haklev, 2005).

There are multiple different ways of evaluating the findings as many of the authors focuses on the same aspects of the models but from different angels. The authors are also often studying different and/or multiple organizations, villages, LFs and FFs, which means that some programs might have more positive results than other programs and vice versa. Several academic papers have been analyzed and many of them have uncovered the same results, though some authors have contradicting results. For example, Andersen stated that farmers are often more comfortable asking lead farmers for help and advice since they already trust them instead of extension workers (Andersen, 2019). While Ragasa found very contradicting results, she collected stories and comments from farmers who practice the Lead Farmers model in Malawi. Several people commented that the community usually undermines the lead

farmers because of a lack of trust and jealousy. They believe that the extension workers are more skilled, and they would rather trust them than LFs (Ragasa, 2019). On the other hand, most of the authors found that lead farmers are often undermined because of biases and "class" differences. They also found that people who has had most success with encouraging others to adopt new agricultural technologies are peer-farmers who have similar resource access as the rest of the farmers.

Only 69 percent of the lead farmers stated that they received training in technical topics such as agricultural technologies and farming methods. Only 43 percent of the farmers reported that they received training materials to help them perform their work (Tchuwa & Simpson, 2015). Model 3 indicates that the objective is more likely to last if farmers experience increased food diversification and accessibility. To experience increased food diversification and accessibility one needs to have quality training in technical topics such as agricultural technologies and farming methods. If this training is incomprehensive, the objective will prove to be less effective. The percentage of people receiving such training indicates a lack of achievement in the interventions objectives and results. Such a low percentage of people receiving the necessary training will affect the entire program impactfully, effectively and sustainably.

Extensive knowledge about agricultural technologies is imperative for the intervention to be effective. Certain correlated values from the analysis section indicates that when *Crop rotation* increases, *Food accessibility* simultaneously increases and when *Crop rotation* increases, *Economy* simultaneously increases, furthermore when *Crop rotation* increases, *Intercropping* simultaneously increases. This indicates that knowledge of- and extensive training in agricultural technologies is a cornerstone for the program to be effective. Food diversification and food accessibility is enhanced using agricultural technologies, by for example practicing crop rotation and intercropping. As was noted in the analysis chapter, intercropping is the practice where one plants multiple different crops in a field and crop rotation is the practice of planting different kinds of crops sequentially to boost resilience, to improve soil health, to optimize nutrients in the soil and to combat occurring pests and diseases (Andersen, 2019). By practicing CA techniques and agricultural technologies farmers will experience more reliable crops, more food diversification and food accessibility as well as food surplus. This will in turn lead to a better household economy and enhanced life quality, as well as a more effective program that achieves its goals.

6.1 Sustainability of the program

Assessing sustainability allows evaluators to determine if an intervention's benefits will last financially, economically, socially, and environmentally. The OECD criteria for Sustainability is closely related to effectiveness and impact: to determine if the objective will last, one must first address if the results have been achieved (effectiveness) and if one can see if any greater effects have been achieved and demonstrated (impact) (OECD, 2022). The Barefoot Doctors model has previously experienced issues with long-term sustainability due to the global recession. It is therefore imperative to use the OECD evaluation criterions to ensure that the intervention will achieve long-term sustainability. The goal of the objective is to combat rural poverty by focusing on agriculture as well as preparing the rural population of the global south for rising temperatures and more extreme weather conditions.

6.1.1 Institutional sustainability

Institutional sustainability is the practice to ensure new norms and practices to achieve sustainable and long-lasting development initiatives (Johnson & Wilson, 1999). DF and its partners in Malawi created the first extension services guide: The lead farmer extension and training guide, in collaboration with the government and other NGOs. This guide ensures that organizations, institutions, and associations know their responsibilities and roles as well as it creates a more stable and reliable flow of knowledge transfers (Andersen, 2019) Institutional sustainability ensures that policies, systems, structures, and procedures at a local level are in place, functional and met by the time NGOs leave. It is important that a system have been established and that it is functional when NGOs leave since the objective is supposed to be self-sustaining after a period. Institutional sustainability seeks to ensure that the practice of an objective is deeply embedded in the structures of a society when NGOs decide that the objective has reached its goal and therefore, ends. It wants to guarantee the autonomy of a society/village to continue the practices by themselves and on their own merits when the initial project has finished. To provide long-lasting sustainability and effectiveness of the program one needs to have on-going action learning and investigate the causes and effects of the initiative. This thesis has investigated the causes and effects of agricultural extension services, it has evaluated two models and assessed both the positive and negative aspects of the models. The results of the actions, interventions and initiatives taken by the organizations

have been characterized, this will enable further possibilities for assessment and learning. It will further determine what parts of the two models can supplement each other to create the best possible model for agricultural extension services and continuing institutional sustainability (Johnson & Wilson, 1999).

6.1.2 Financial sustainability

Financial sustainability suggest that it is important that institutions can continue to provide the same volume of education, training, goods, and services and that they have the resources needed to continue to provide these goods and services in the future without becoming indebted (Galera, Bolívar, Muñoz & Subires, 2016). The Barefoot Doctor's initiative might therefore have a disadvantage as they acquire a salary and will be more expensive. While the Lead Farmer method has an advantage as they use volunteers and will thus be free of charge. As noted earlier, some farmers believe that the selection process to become an LF and to receive benefits at an early stage is biased. Therefore, to somewhat fix this issue: instead of focusing on a salary it might be a financial sustainable option to provide new follower farmers with a start-up package that would include essential products like seeds, implements and fertilizers to make sure that poor or less "funded" farmers do not fall out of the program. This will be a one-time contribution that will allow the farmers to start the program, they will then re-use the seeds every year as well as they will learn how to make organic fertilizers from scratch. The goal of the program is that farmers will eventually experience food diversification, food accessibility and food surplus. This will lead to an increased economy which can be used to buy new implements or tools to fix the old implements. It could also be financially sustainable and motivational to follow Andersen's suggestion. She believes that livestock should be distributed in greater numbers to ensure that everybody will receive their animals before four years has passed. This will ensure that people do not drop out of the program because they must wait almost a lifetime before receiving any benefits from it (Andersen, 2019). It is important to focus on the follower farmers as well as the lead farmers to ensure that the program will last and to ensure that the program has participants that feel like their needs are being met.

6.1.3 Technical sustainability

The technical sustainability of extension services is reached when local people/people who are participating in the program has the resources and technical expertise to continue the program when the initiative ends (Vacchi, Siligardi, Demaria, Cedillo-González, González-Sánchez, Settembre-Blundo, 2021). One of the limitations of the Lead Farmers approach was poor quality training. The results of both the literature review and the data analysis states that LF training is too short and not comprehensive enough. This indicates support for the alternative hypothesis, "the variables provide some support for the Barefoot Doctor's model". The training of the barefoot doctors lasted for approximately six months, giving them time to properly learn new skills and reflect on what they have learned (Haklev, 2005).
The Barefoot Doctors model also invented the concept of continued in-service training to prevent knowledge drain. For the Barefoot Doctor's model this meant that 15 percent of all doctors would be stationed in rural areas on rotation, this allowed them to continue the education of the barefoot doctors as well as they themselves learned about rural illnesses and treatments. This is another aspect of the Barefoot Doctors' model which could be beneficial to implement in the Lead Farmer's approach (Haklev, 2005). Some extension workers should constantly be out in the field, on rotation, continuing the education and schooling of lead farmers as well as they themselves would learn more about the struggles, victories, wants, and needs of the farmers. It is important to visit the farms and provide on-site advice to encourage and motivate the farmers to practice new agricultural technologies. If extension workers and lead farmers rotate the farms they visit and visit them continuously they will motivate the beneficiaries to become more committed to the adoption of CA. It would allow them to learn more and faster and it might create more trust between all parties. This would also allow the extension workers to get a better understanding of what is needed to create a sustainable and long-lasting program as well as creating a reliable structure for all parties (Mulwafu & Krishnankutty, 2012).

6.1.4 Motivational sustainability

Motivational sustainability is an internal state that drives, directs and sustain human behavior and choices. The motivation to act in a certain way as well as the motivation to keep on

participating in further similar activities is crucial to ensure that the initiative lasts (Hansmann, 2010). Tchuwa & Simpson specify that it would be challenging to give lead farmers a salary and/or compensation as motivation for the work they are doing as that would cause them to be perceived as another class, hence, no longer "equal" to the other farmers (Tchuwa & Simpson, 2015). Model 2 suggests from the analysis section indicates that people who believe that the objective will last when the Development Fund leaves also believes that LFs motivation to work would not improve with a salary or compensation. Volunteering as an LF is seen as an altruistic activity, it enhances life quality by producing a feeling of self-worth and accomplishment. Farmers also gain motivation to work as lead farmers as it allows them to obtain knowledge to improve their own farms at an early stage, early access to new technologies and because they can take part in income generating activities (Tchuwa & Simpson, 2015).

When farmers receive livestock, it might be motivational to also receive home visits from LFs. In the Barefoot Doctor's initiative, the barefoot doctors make five home visits after birth to care for the newborns at home. They counsel families on practices regarding healthy growth and development: illness prevention, vaccines and feeding, etc. This is a practice that would be highly motivational and effective to include in the Lead Farmers initiative regarding livestock (Aboubaker, Qazi, Wolfheim, Oyegoke & Bahl, 2014).

The Lead Farmers model has achieved positive results and unintended negative results as well as it has demonstrated negative and positive impacts of the project. Some of the negative effects listed throughout the thesis has been young people dropping out of the program, poor quality LFs, inadequate training, knowledge drain and biased selection processes. Then again it has also proven to be somewhat effective, impactful and relevant as the initiative has achieved positive outcomes like, improved disaster risk reduction, improved soil quality, increased food accessibility and food diversification. It is therefore imperative to use the OECD evaluation criterions to analyze the causes and effects of the outcomes and to administer on-going action learning to ensure that the intervention will achieve long-term sustainability. Nevertheless, the Lead Farmers model has its limitations and to ensure the long-term viability of the project one should seek to implement aspect from the Barefoot Doctor's initiative to achieve the goal of the initial problem statement "How can we *sustainably provide services in rural areas in the global south?"*.

Chapter seven

Recommendations

1. The first step must be to ensure that all Lead Farmer programs must allow farmers themselves to conduct their own needs assessment. Every organization must ensure that they target farmers felt needs and allow them to decide what efforts should be implemented as it is them who must live with the everyday struggles, successes, hardships, and victories of the initiative. It is also them who knows best what climate challenges causes the most problems, what disaster risk reduction measures they need and what agricultural technologies would be most efficient for the climate they live in. Long-term sustainability will be more likely if one focuses on farmers felt needs. This will ensure that they feel heard and that they feel like their needs are being met which will further guarantee their continuity of the program.
2. The next step must be to address the issues of problematic selection processes. It is important to address what is needed for farmers to feel like it is not a biased selection process. The literature review found that lead farmers often have bigger farms, more resources, and more wealth than other farmers. This results in some farmers and communities feeling like progressive and elite farmers receive benefits because of their status. Because of this struggle, it is important that LFs are picked by the entire community and not by extension workers, committees, or heads of the village. Consequently, it might be important to formulate strict rules that will be the manual for choosing an LF to avoid previous problems of biased selection processes and limited participation in the selection processes. Many farmers state that they have experienced that the selection process to become a lead farmer lacks participation, transparency, and attendance.
3. It is important that farmers who become lead farmers are perceived as good quality farmers. It is important to choose LFs that enjoy working with and helping others to create a sustainable program that ensures the continuity of the objective.
4. One of the most important aspects is the initial and regular training of LFs in agricultural technologies. It could be beneficial to use the same practices as the Barefoot Doctor's model, to arrange schooling of the lead farmers during the agricultural off-season. It would also be beneficial to have a training course that lasts

for at least a couple of weeks with breaks in-between which will allow them to reflect and remember what they have been taught. It is also imperative to have refreshment trainings yearly to prevent knowledge-drain and distribution of faulty knowledge.

5. It would also be an advantage to practice continued in-service training were some extension workers and lead farmers are regularly out in the field, on rotation. This would allow them to continue the training of both LFs and FFs and to prevent knowledge drain, it would also allow them to motivate the beneficiaries to become more committed to the adoption and continued learning of agricultural technologies. When extension workers and LFs visit farms and rotate the ones they visit continuously they also have the possibility to set weekly/monthly goals for the farmers. These goals should be completed by the next time they will be visited, this encourages goal-orientation and on-going learning.
6. It might be beneficial to incorporate the Barefoot Doctors practice of home visits. This is a practice that would be highly motivational and effective to include in the Lead Farmers initiative. Lead farmers should make home visits after follower farmers have received new livestock to teach them livestock management training: breeding, housing, and feeding, as well as disease and pest management. This would encourage and motivate the farmers to properly take care of their livestock and it would decrease the high death rates of livestock, due to poor training of farmers.
7. Farmers should be provided with start-up packages that will allow them to participate in the program. This will ensure that poor, less funded and marginalized people does not fall out of the program. It is also important to focus on the pass-on-system and ensure that people will receive and practice livestock activities in a reasonable amount of time. If this system and other advantages of the program takes too long, one will again experience people dropping out as they don't experience any benefits.
8. It is important to continuously have on-going action learning and investigations of the causes and effects of the initiative. This will allow the initiative to always evaluate which measures are effective and sustainable and which are not.

Chapter eight

Conclusion

This thesis has found evidence for the alternative hypothesis, the variables provide some support for the Barefoot Doctor's model. While it is good applying one model, it is always advantageous utilizing aspects of two or more models, particularly in such complex domains as extension services. As this thesis has discovered, the Lead Farmers model is a good model for agricultural provisional extension services, but it has its limitations. These limitations can be met and resolved by implementing aspects of other models. This thesis has looked at the parallels of the Barefoot Doctor's initiative and the Lead Farmers initiative to determine if these two models can supplement each other to create long-term sustainability of agricultural extension services. It found that by implementing elements from the Barefoot Doctor's model, like longer education, continued in-service training, home-visits and on-going action learning, the Lead Farmers model will improve its effectiveness, impact, relevance, and long-term sustainability. A combination of these two models might remove the negative effects that has been listed throughout this text, some new negative effects might evidently occur, but that is part of the ongoing action-learning process.

Future research possibilities would include a bigger and more varied sample of respondents who participate in the Lead Farmers initiative in Malawi. It would be useful to review the questionnaire and include a more varied and multilayered set of questions to fully analyze all the complex aspects of an initiative that affects people's lives. Another important aspect for future work would be to analyze the Barefoot Doctor's initiative in Malawi through household-surveys, interviews, and questionnaires etc. It is essential to properly research the extent of the Barefoot Doctor's initiative and whether the results are as positive as the literature indicates.

All in all, the goal of agricultural extension services is to create autonomy and sustainability. Creating autonomy allows the beneficiaries of a project to make decisions that are in their best interest. This aligns with the concept of bottom-up development which emphasizes the participation and involvement of the local community in decision-making processes and development initiatives so they themselves can decide their own goals and the means of achieving these goals. Using the positive elements from both the Lead Farmers and Barefoot

Doctors' model might be a way to reach autonomy more effectively and to ensure the long-term sustainability of the project. Finally, the world is facing a wetter, dryer, and wilder climate and it is therefore imperative to create new and sustainable technologies and methods that will help everybody face this new environment, without risking future generation's ability to meet their resource needs.

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Appendix

Correlated values

Table 2, P-value of the correlated variables.

Variable	Gender	food_accessibility	food_diversification	production_and_increased_yields	diversification_of_livestock	adapt_to_climate_related_stresses_or_challenges	disaster_risk_reduction	economy	Improved_soil_quality
Gender	0,00	0,92	0,64	0,50	0,55	0,0731*	0,76	0,44	0,17
food_accessibility	0,92	0,00	0,0182*	0,43	0,24	0,37	0,50	0,0861*	0,19
food_diversification	0,64	0,0182*	0,00	0,42	0,0994*	0,16	0,24	0,11	0,0805*
production_and_increased_yields	0,50	0,43	0,42	0,00	0,81	0,88	0,29	0,76	0,75
diversification_of_livestock	0,55	0,24	0,0994*	0,81	0,00	0,12	0,14	0,51	0,28
adapt_to_climate_related_stresses_or_challenges	0,0731*	0,37	0,16	0,88	0,12	0,00	0,36	0,23	0,0394*
disaster_risk_reduction	0,76	0,50	0,24	0,29	0,14	0,36	0,00	0,84	0,42
economy	0,44	0,0861*	0,11	0,76	0,51	0,23	0,84	0,00	0,0508*
Improved_soil_quality	0,17	0,19	0,0805*	0,75	0,28	0,0394*	0,42	0,0508*	0,00
climate_science	0,90	0,85	0,65	0,0683*	0,89	0,96	0,19	1,00	0,71
Agricultural_technologies	0,79	0,92	1,00	0,66	0,35	0,92	0,65	0,44	0,60
Crop_rotation	0,55	0,0423*	0,0791*	0,72	0,44	0,25	0,81	0,0014**	0,076*
Intercropping	0,15	0,21	0,12	0,81	0,17	0,0165*	0,61	0,09	0,0401*
organic_fertilizer	0,13	0,38	0,53	0,14	0,70	0,61	0,54	1,00	0,80
Current _mpacts_of_climate_change_in_Malawi	0,22	0,92	0,64	0,91	0,35	0,22	0,14	1,00	0,41
Future_impacts_of_climate_change_in_Malawi	0,35	0,62	0,37	0,72	0,0345*	0,12	0,28	0,79	0,43
prepared_for_floods	0,90	0,34	0,65	0,83	0,89	0,96	0,35	0,23	0,71
prepared_for_Droughts	0,87	0,59	0,78	0,44	0,46	0,81	0,68	0,33	0,63
prepared_for_Pests	0,50	0,30	0,56	0,30	0,72	0,72	0,78	0,33	0,75
prepared_for_Extreme_rain	0,50	0,88	0,70	0,69	0,38	0,43	0,0741*	0,76	0,63
prepared_for_Change_in_seasonality	0,50	0,81	1,00	0,30	0,72	0,72	0,20	0,33	0,63
prepared_for_Extreme_heat	0,22	0,55	0,64	0,0123*	1,00	0,55	0,48	1,00	0,90
too_long_to_experience_benefits	0,46	0,75	0,91	0,15	0,43	0,49	0,94	0,73	0,98
LF_training_is_too_short	0,60	0,85	0,86	0,83	0,33	1,00	0,66	0,56	0,61
overworked	0,81	0,43	0,51	0,41	0,74	0,81	0,95	0,16	0,32
improved_motivation_with_salary_or_compensation	0,50	0,12	0,18	0,30	0,23	0,81	0,34	0,65	0,75
biased	0,90	0,60	0,82	0,83	0,47	0,96	0,42	0,23	0,57
will_the_objective_last_when_the_Development_fund_leaves	0,79	0,0731*	0,0577*	0,15	0,17	0,55	0,14	0,44	0,41

Table 3, P-value of the correlated variables.

Variable	climate_science	Agricultural_technologies	Crop_rotation	Intercropping	organic_fertilizer	Current _mpacts_of_climate_change_in_Malawi	Future_impacts_of_climate_change_in_Malawi
Gender	0,8982	0,7888	0,5504	0,1482	0,1328	0,2191	0,3456
food_accessibility	0,8531	0,9234	0,0423*	0,2131	0,3775	0,9234	0,6186
food_diversification	0,6514	1	0,0791*	0,124	0,5305	0,6376	0,3677
production_and_increased_yields	0,0683*	0,6578	0,7207	0,807	0,1382	0,9134	0,7207
diversification_of_livestock	0,8906	0,3506	0,4441	0,1697	0,7043	0,3506	0,0345*
adapt_to_climate_related_stresses_or_challenges	0,9632	0,9234	0,2542	0,0165*	0,6054	0,2234	0,1176
disaster_risk_reduction	0,1905	0,647	0,8069	0,6067	0,5424	0,1449	0,2758
economy	1	0,4397	0,0014**	0,0917*	1	1	0,7911
Improved_soil_quality	0,7088	0,5993	0,076*	0,0401*	0,8006	0,4128	0,4327
climate_science	0	0,5993	0,9632	0,7733	0,5436	0,4128	0,8531
Agricultural_technologies	0,5993	0	0,5504	1	0,7244	0,7888	0,2234
Crop_rotation	0,9632	0,5504	0	0,0984*	0,8498	0,9234	0,7525
Intercropping	0,7733	1	0,0984*	0	0,6925	0,5367	0,2131
organic_fertilizer	0,5436	0,7244	0,8498	0,6925	0	0,5908	0,8498
Current _mpacts_of_climate_change_in_Malawi	0,4128	0,7888	0,9234	0,5367	0,5908	0	0,2234
Future_impacts_of_climate_change_in_Malawi	0,8531	0,2234	0,7525	0,2131	0,8498	0,2234	0
prepared_for_floods	0,3492	0,5993	0,1936	0,554	0,8668	0,1697	0,6724
prepared_for_Droughts	0,6309	0,0276*	0,3734	1	0,8304	0,495	0,1878
prepared_for_Pests	0,7519	0,2722	0,2952	1	0,3534	0,2722	0,2952
prepared_for_Extreme_rain	0,2635	0,6578	0,7207	0,807	0,8867	0,0123*	0,2952
prepared_for_Change_in_seasonality	0,2006	0,495	0,3734	0,4397	0,3534	0,495	0,813
prepared_for_Extreme_heat	0,1697	0,7888	0,9234	0,5367	0,0534*	0,7888	0,5504
too_long_to_experience_benefits	0,2945	0,1414	0,7464	0,5581	0,4569	0,5555	0,1251
LF_training_is_too_short	0,6116	0,0068**	0,7059	1	0,4784	1	0,3024
overworked	0,5253	0,0321*	0,2152	0,6798	0,9368	0,8077	0,4295
improved_motivation_with_salary_or_compensation	0,7519	0,495	0,4983	0,712	0,056*	0,8703	0,5855
biased	0,951	0,0486*	0,2774	0,7733	0,8668	0,4128	0,2774
will_the_objective_last_when_the_Development_fund_leaves	0,4128	0,7888	0,3456	0,5367	0,1328	0,7888	0,5504

Table 4, P-value of the correlated variables.

Variable	prepared_for_floods	prepared_for_Droughts	prepared_for_Pests	prepared_for_Extreme_rain	prepared_for_Change_in_seasonality	prepared_for_Extreme_heat
Gender	0,8982	0,8703	0,495	0,495	0,495	0,2191
food_accessibility	0,3375	0,5855	0,2952	0,875	0,813	0,5504
food_diversification	0,6514	0,7761	0,5594	0,7027	1	0,6376
production_and_increased_yields	0,834	0,4376	0,3019	0,685	0,3019	0,0123*
diversification_of_livestock	0,8906	0,4601	0,7231	0,3782	0,7231	1
adapt_to_climate_related_stresses_or_challenges	0,9632	0,813	0,7207	0,4279	0,7207	0,5504
disaster_risk_reduction	0,3476	0,6751	0,782	0,0741*	0,1989	0,4797
economy	0,2276	0,3273	0,3273	0,7641	0,3273	1
Improved_soil_quality	0,7088	0,6309	0,7519	0,6309	0,6309	0,8982
climate_science	0,3492	0,6309	0,7519	0,2635	0,2006	0,1697
Agricultural_technologies	0,5993	0,0276*	0,2722	0,6578	0,495	0,7888
Crop_rotation	0,1936	0,3734	0,2952	0,7207	0,3734	0,9234
Intercropping	0,554	1	1	0,807	0,4397	0,5367
organic_fertilizer	0,8668	0,8304	0,3534	0,8867	0,3534	0,0534*
Current _mpacts_of_climate_change_in_Malawi	0,1697	0,495	0,2722	0,0123*	0,495	0,7888
Future_impacts_of_climate_change_in_Malawi	0,6724	0,1878	0,2952	0,2952	0,813	0,5504
prepared_for_floods	0	0,3482	0,2006	0,0683*	0,1162	0,8982
prepared_for_Droughts	0,3482	0	*	0,4376	0,534	0,495
prepared_for_Pests	0,2006	0,052*	0	0,3019	0,685	0,2722
prepared_for_Extreme_rain	0,0683*	0,4376	0,3019	0	0,2191	0,9134
prepared_for_Change_in_seasonality	0,1162	0,534	0,685	0,2191	0	0,2722
prepared_for_Extreme_heat	0,8982	0,495	0,2722	0,9134	0,2722	0
too_long_to_experience_benefits	0,7352	0,0526*	0,0851*	0,6739	0,8765	0,1414
LF_training_is_too_short	0,8034	0,1114	0,5101	0,8327	0,5101	1
overworked	0,4206	0,0127*	0,1124	0,688	0,5382	0,5742
improved_motivation_with_salary_or_compensation	0,7519	0,9205	0,534	0,947	0,534	0,2722
biased	0,1608	0,0213*	0,1162	0,2635	0,2006	0,8982
will_the_objective_last_when_the_Development_fund_leaves	0,8982	0,8703	0,495	0,6578	0,495	0,2191

Table 5, P-value of the correlated variables.

Variable	too_long_to_experience_benefits	LF_training_is_too_short	overworked	improved_motivation_with_salary_or_compensation	biased	will_the_objective_last_when_the_Development_fund_leaves
Gender	0,4628	0,5963	0,8077	0,495	0,8982	0,7888
food_accessibility	0,7464	0,8519	0,4295	0,1245	0,602	0,0731*
food_diversification	0,9126	0,8579	0,5117	0,1817	0,824	0,0577*
production_and_increased_yields	0,1488	0,8327	0,4135	0,3019	0,834	0,1456
diversification_of_livestock	0,4261	0,3318	0,7426	0,2276	0,4699	0,1736
adapt_to_climate_related_stresses_or_challenges	0,4868	1	0,809	0,813	0,9632	0,5504
disaster_risk_reduction	0,9433	0,6579	0,9458	0,3423	0,4217	0,1449
economy	0,7257	0,5594	0,1643	0,6488	0,2276	0,4397
Improved_soil_quality	0,9757	0,6116	0,3215	0,7519	0,5682	0,4128
climate_science	0,2945	0,6116	0,5253	0,7519	0,951	0,4128
Agricultural_technologies	0,1414	0,0068**	0,0321*	0,495	0,0486*	0,7888
Crop_rotation	0,7464	0,7059	0,2152	0,4983	0,2774	0,3456
Intercropping	0,5581	1	0,6798	0,712	0,7733	0,5367
organic_fertilizer	0,4569	0,4784	0,9368	0,056*	0,8668	0,1328
Current _mpacts_of_climate_change_in_Malawi	0,5555	1	0,8077	0,8703	0,4128	0,7888
Future_impacts_of_climate_change_in_Malawi	0,1251	0,3024	0,4295	0,5855	0,2774	0,5504
prepared_for_floods	0,7352	0,8034	0,4206	0,7519	0,1608	0,8982
prepared_for_Droughts	0,0526*	0,1114	0,0127*	0,9205	0,0213*	0,8703
prepared_for_Pests	0,0851*	0,5101	0,1124	0,534	0,1162	0,495
prepared_for_Extreme_rain	0,6739	0,8327	0,688	0,947	0,2635	0,6578
prepared_for_Change_in_seasonality	0,8765	0,5101	0,5382	0,534	0,2006	0,495
prepared_for_Extreme_heat	0,1414	1	0,5742	0,2722	0,8982	0,2191
too_long_to_experience_benefits	0	0,2703	0,1233	0,8765	0,2374	0,7
LF_training_is_too_short	0,2703	0	0,0985	0,292	0,1235	0,5963
overworked	0,1233	0,0985*	0	0,9704	0,0418*	0,7129
improved_motivation_with_salary_or_compensation	0,8765	0,292	0,9704	0	0,7519	0,0276*
biased	0,2374	0,1235	0,0418	0,7519	0	0,8982
will_the_objective_last_when_the_Development_fund_leaves	0,7	0,5963	0,7129	0,0276*	0,8982	0

Explanation of the correlated values

The correlation between the variables *economy* and food *accessibility* has a positive effect. both variables move in tandem, this indicates that when the variable food accessibility increases, the variable economy also increases. The correlation between these two variables has a P-value of 0.086* making them statistically significant.

The correlation between *Economy* and *intercropping* has a positive effect. This indicates that when the variable intercropping increases, the economy variable will also increase. The correlation between these two variables has a P-value of 0.092* making them statistically significant.

The correlation between *Organic fertilizer* and *prepared for extreme heat* has a positive effect. This indicates that when the variable organic fertilizer increases, the variable prepared for extreme heat will also increase. The correlation between these two variables has a P-value of 0.053* making them statistically significant.

The correlation between *Prepared for pests* and *prepared for droughts* has a positive effect. This indicates that when the variable prepared for pests increases, the variable prepared for droughts will also increase. The correlation between these two variables has a P-value of 0.052* making them statistically significant.

The correlation between *Prepared for extreme rain* and *prepared for floods* has a positive effect. This indicates that when the variable prepared for extreme rain increases, the variable prepared for floods will also increase. The correlation between these two variables has a P-value of 0.068* making them statistically significant.

The correlation between *Too long to experience benefits* and *prepared for droughts* has a has a positive effect. This indicates that when the variable too long to experience benefits from the program increases, the variable prepared for droughts also increases. The correlation between these two variables has a P-value of 0.053* making them statistically significant.

The correlation between *Too long to experience benefits* and *prepared for pests* has a positive effect. This indicates that when the variable too long to experience benefits from the program

increase, the variable prepared for pests also increase. The correlation between these two variables has a P-value of 0.085* making them statistically significant.

The correlation between *LF training is too short* and *overworked* has a positive effect. This indicates that when the variable LF training is too short increase, the variable overworked also increases. This indicates that the LF training should be longer to reduce workloads. The correlation between these two variables has a P-value of 0.099* making them statistically significant.

The correlation between *Overworked* and *prepared for droughts* has a positive effect. This indicates that when the variable LFs are overworked increase, the variable prepared for droughts also increase. The correlation between these two variables has a P-value of 0.013* making them statistically significant.

The correlation between *Biased* and *prepared for droughts* has a positive effect. This indicates that when the variable the selection process to be an LF and to experience benefits at an early stage is biased increase, the variable prepared for droughts also increase. The correlation between these two variables has a P-value of 0.021* making them statistically significant.

The correlation between *Biased* and *overworked* has a positive effect. This indicates that when the variable selection process to be an LF and to experience benefits at an early stage is biased increase, the variable overworked also increase. This indicates that the correlation between these two variables has a P-value of 0.042* making them statistically significant.

The correlation between *Improved motivation with salary* and *will the objective last when the development fund leaves* have a negative effect. This indicates that when the variable the objective will last when the Development Fund leaves increase, motivation to work would be improved with a salary or compensation also increase. The correlation between these two variables has a P-value of 0.028* making them statistically significant.

The correlation between *Biased* and *agricultural technologies has a negative effect*. This negative correlation means that when the variable knowledge of agricultural technologies

increase, the variable LF selection process is biased decrease and vice versa. The correlation between these two variables has a P-value of 0.049* making them statistically significant.

The correlation between the variables *Prepared for extreme rain* and *disaster risk reduction* has a negative effect. This indicates that when the variable prepared rain increase, the variable disaster risk reduction decreases. The correlation between these two variables has a P-value of 0.074* making them statistically significant.

The correlation between *Current impacts of climate change in Malawi* and *prepared for extreme rain* has a negative effect. This indicates that when the variable knowledge of current impacts of climate change in Malawi increase, the variable prepared for rain decrease and vice versa. The correlation between these two variables has a P-value of 0.012* making them statistically significant.

The correlation between the variables *Will the objective last when the development fund leaves*? and *food accessibility* has a positive effect. This indicates that when the variable high food accessibility increase, the variable will the objective last when the Development Fund leaves increases. The correlation between these two variables has a P-value of 0.073* making them statistically significant.

The correlation between the variables *Diversification of livestock* and *food diversification* has a positive effect. This indicates that when the variable food diversification increase, the variable diverse livestock increases. The correlation between these two variables has a P-value of 0.099* making them statistically significant.

The correlation between the variables Improved *soil quality* and *food diversification* has a positive effect. This indicates that when the variable soil quality increase, the variable food diversification will increase. The correlation between these two variables has a P-value of 0.081* making them statistically significant.

The correlation between the variables *Crop rotation* and *food diversification* has a positive effect. This indicates that when the variable crop rotation increases, the variable food diversification will also increase. The correlation between these two variables has a P-value of 0.079* making them statistically significant.

The correlation between the variables *Will the objective last when the development fund leaves,* and *food diversification* has a positive effect. This indicates that if the variable food diversification increases, the variable will the objective last when the Development Fund leaves increases. The correlation between these two variables has a P-value of 0.057* making them statistically significant.

The correlation between the variables *Climate science* and *production and increased yields* has a positive effect. This indicates that if the variable knowledge about climate science increases, the variable production and increased yields will increase. The correlation between these two variables has a P-value of 0.068* making them statistically significant.

The correlation between the variables *Prepared for extreme heat* and *production and increased yields* is neutral. This indicates that the variables are unrelated. The correlation between these two variables has a P-value of 0.012* making them statistically significant.

The correlation between the variables *Future impacts of climate change in Malawi* and *diversification of livestock* has a positive effect. This indicates that when the variable knowledge about future impacts of climate change in Malawi increase, the variable diversification of livestock increases. The correlation between these two variables has a P-value of 0.035* making them statistically significant.

The correlation between the variables *Adapt to climate related stresses and challenges* and *improved soil quality* has a positive effect. This indicates that when the variable improved soil quality increases, the variable adapting to climate related stresses and challenges also increases. The correlation between these two variables has a P-value of 0.039* making them statistically significant.

The correlation between the variables *Adapt to climate related stresses and challenges* and *intercropping* has a positive effect. This indicates that when the variable intercropping increase, the variable adapting to climate related stresses and challenges also increase. The correlation between these two variables has a P-value of 0.017* making them statistically significant.

The correlation between the variables *Improved soil quality* and *economy* has a positive effect. This indicates that when the variable improved soil quality increase, the variable improved economy increases. The correlation between these two variables has a P-value of 0.051* making them statistically significant.

The correlation between the variables *Improved soil quality* and *crop rotation* has a positive effect. This indicates that when the variable crop rotation increase, the variable improved soil quality increases. The correlation between these two variables has a P-value of 0.076* making them statistically significant.

The correlation between the variables *improved soil quality* and *intercropping* has a positive effect. This indicates that when the variable improved soil quality increase, the variable intercropping increases. The correlation between these two variables has a P-value of 0.040* making them statistically significant.

R script

```
# Install packages

install.packages("ggplot2")
install.packages("tidyverse")
install.packages("dplyr")
install.packages("openintro")
install.packages("broom")
install.packages("cowplot")
install.packages("ggcorrplot")

# Load libraries
library(ggplot2)
library(dplyr)
library(openintro)
library(tidyverse)
library(broom)
```

```
library(cowplot)
library(ggcorrplot)

Master.data1 <- Interview_answers %>%
  dplyr::select(gender = Gender,
                food_accessibility = Food_accessibility,
                food_diversification = Food_diversification,
                production_and_increased_yields = Production_and_increased_yields,
                diversification_of_livestock = Diversification_of_livestock,
                adapt_to_climate_related_stresses_or_challenges =
Adapt_to_climate_related_stresses_or_challenges,
                disaster_risk_reduction = Disaster_risk_reduction,
                economy = Economy,
                improved_soil_quality = Improved_soil_quality,
                climate_science = Climate_science,
                agricultural_technologies = Agricultural_technologies,
                crop_rotation = Crop_rotation,
                intercropping = Intercropping,
                organic_fertilizer = Organic_fertilizer) %>%
  mutate(Gender_recode = ifelse(gender == 1, 0, 1)) %>%
  drop_na()

view(Master.data)

table(Master.data$Gender_recode)

summary(Master.data$Gender_recode)
sd(Master.data$Gender_recode)

summary(Master.data1$Food_accessibility)
sd(Master.data1$Food_accessibility)

summary(Master.data1$Food_diversification)
sd(Master.data1$Food_diversification)
```

```
summary(Master.data1$Production_and_increased_yields)
sd(Master.data1$Production_and_increased_yields)

summary(Master.data1$Diversification_of_livestock)
sd(Master.data1$Diversification_of_livestock)
summary(Master.data$Adapt_to_climate_related_stresses_or_challenges)
sd(Master.data$Adapt_to_climate_related_stresses_or_challenges)

summary(Master.data$Disaster_risk_reduction)
sd(Master.data$Disaster_risk_reduction)

summary(Master.data$Economy)
sd(Master.data$Economy)

summary(Master.data$Improved_soil_quality)
sd(Master.data$Improved_soil_quality)

summary(Master.data$Climate_science)
sd(Master.data$Climate_science)

summary(Master.data$Agricultural_technologies)
sd(Master.data$Agricultural_technologies)

summary(Master.data$Crop_rotation)
sd(Master.data$Crop_rotation)

summary(Master.data$Intercropping)
sd(Master.data$Intercropping)

summary(Master.data$Organic_fertilizer)
sd(Master.data$Organic_fertilizer)

Master.data2 <- Interview_answers_ %>%
```

```
  dplyr::select(current_impacts_of_climate_change_in_Malawi =
Current_impacts_of_climate_change_in_Malawi,
                future_impacts_of_climate_change_in_Malawi  =
Future_impacts_of_climate_change_in_Malawi,
                prepared_for_floods = Prepared_for_floods,
                prepared_for_Droughts = Prepared_for_Droughts,
                prepared_for_Pests = Prepared_for_Pests,
                prepared_for_Extreme_rain = Prepared_for_Extreme_rain,
                prepared_for_Change_in_seasonality = Prepared_for_Change_in_seasonality,
                prepared_for_Extreme_heat = Prepared_for_Extreme_heat,
                too_long_to_experience_benefits = Too_long_to_experience_benefits,
                lf_training_is_too_short = LF_training_is_too_short,
                overworked = Overworked,
                improved_motivation_with_salary_or_compensation =
Improved_motivation_with_salary_or_compensation,
                biased = Biased,
                will_the_objective_last_when_the_Development_fund_leaves =
Will_the_objective_last_when_the_Development_fund_leaves) %>%
  mutate(Gender_recode = ifelse(Gender == 1, 0, 1)) %>%
  drop_na()

summary(Master.data$Current_impacts_of_climate_change_in_Malawi)
sd(Master.data$Current_impacts_of_climate_change_in_Malawi)

summary(Master.data$Future_impacts_of_climate_change_in_Malawi)
sd(Master.data$Future_impacts_of_climate_change_in_Malawi)

summary(Master.data$Prepared_for_floods)
sd(Master.data$Prepared_for_floods)

summary(Master.data$Prepared_for_Droughts)
sd(Master.data$Prepared_for_Droughts)

summary(Master.data$Prepared_for_Pests)
```

```
sd(Master.data$Prepared_for_Pests)

summary(Master.data$Prepared_for_Extreme_rain)
sd(Master.data$Prepared_for_Extreme_rain)

summary(Master.data$Prepared_for_Change_in_seasonality)
sd(Master.data$Prepared_for_Change_in_seasonality)

summary(Master.data$Prepared_for_Extreme_heat
sd(Master.data$Prepared_for_Extreme_heat)

summary(Master.data$Too_long_to_experience_benefits)
sd(Master.data$Too_long_to_experience_benefits)

summary(Master.data$LF_training_is_too_short,)
sd(Master.data$LF_training_is_too_short,)

summary(Master.data$Overworked)
sd(Master.data$Overworked)

summary(Master.data$Improved_motivation_with_salary_or_compensation)
sd(Master.data$Improved_motivation_with_salary_or_compensation)

summary(Master.data$Biased)
sd(Master.data$Biased)

summary(Master.data$Will_the_objective_last_when_the_Development_fund_leaves)
sd(Master.data$Will_the_objective_last_when_the_Development_fund_leaves)
```

Python script

```
import pandas as pd

from scipy.stats import pearsonr
from scipy import stats
```

```
import matplotlib.pyplot as plt


def calculate_pvalues(df):
    df = df.dropna()._get_numeric_data()
    dfcols = pd.DataFrame(columns=df.columns)
    pvalues = dfcols.transpose().join(dfcols, how="outer")
    for r in df.columns:
        for c in df.columns:
            pvalues[r][c] = round(pearsonr(df[r], df[c])[1], 4)
    return pvalues


# Import data
data = pd.read_excel(
    "Interview-answers.xlsx", engine="openpyxl", usecols="B:O", nrows=5, sheet_name="Ark2"
)

print(data)

print(data.columns)

x = data.columns[2]
y = data.columns[5]

print(f"x: {x}, y: {y}")

res = stats.linregress(data[x], data[y])

print(res)

stars = ""
if res.pvalue < 0.001:
    stars = "***"
elif res.pvalue < 0.01:
    stars = "**"
elif res.pvalue < 0.099:
    stars = "*"


plt.plot(data[x], data[y], "o", label="Data")
plt.xlabel(x)
plt.ylabel(y)
plt.title(f"Linear regression. P-value: {res.pvalue}{stars}")

plt.plot(data[x], res.intercept + res.slope*data[x], 'r', label='fitted line')

plt.legend()
plt.show()

correlated_values = data.corr(method="pearson")
```

```
correlated_values.to_excel(excel_writer="correlated.xlsx", engine="openpyxl")

correlated_values_p = calculate_pvalues(data)
correlated_values_p.to_excel(excel_writer="correlated_p.xlsx", engine="openpyxl")
print(correlated_values_p)


# df = data
# f = plt.figure(figsize=(10, 10))
# plt.matshow(correlated_values_p, fignum=f.number)
# plt.xticks(
#     range(df.select_dtypes(["number"]).shape[1]),
#     df.select_dtypes(["number"]).columns,
#     fontsize=14,
#     rotation=90,
# )
# plt.yticks(
#     range(df.select_dtypes(["number"]).shape[1]),
#     df.select_dtypes(["number"]).columns,
#     fontsize=14,
# )
# cb = plt.colorbar()
# cb.ax.tick_params(labelsize=14)
# plt.title("Correlation Matrix", fontsize=16)
# plt.show()
```

Questionnaire

Master thesis questionnaire:

The questionnaire is anonymous, and your name will therefore not be included in the Master thesis to make sure that the answers stay as objective and truthful as possible. This master thesis is meant to evaluate how effective, impactful, relevant, and sustainable the Lead farmers initiative in Malawi is. It's also supposed to determine if the Lead farmers model should be integrated with the barefoot doctor's model. By assessing the differences and comparing these two models, the thesis might be able to use the positive aspects of both models to find the most efficient and sustainable way to combat rural poverty. Both models have strengths and weaknesses, and the paper wants to determine if these two models can complement each other to create sustainable agricultural development and poverty alleviation.

The barefoot doctor's model:
The model was based on providing individuals at a high school level with a 6-month medical education. The idea was that they would acquire basic knowledge of patient examination, diagnosis, and treatment. This, in turn, would allow people in rural areas to acquire medical help from those trained without delay. The students would get a small salary, which would motivate them to continue the work. If the students could not figure out what disease or treatment to use on their patients, they referred them to educated doctors in urban areas.

This model led to an increase in quality of life for the rural poor. Health knowledge is often so poor in rural areas that providing basic medical knowledge is enough to increase general health, life expectancy, and quality of life.

Please answer this questionnaire as truthfully and objective as possible so that the paper can assess the best possible and most efficient model for provisional extension services. Your answers will only be read by the author of the master thesis and her supervisor. Your answers will further be used to create an analysis of all the combined answers. Please read through the questions carefully and make sure that you properly understand them.

The questionnaire consists of five parts, part one includes eight questions, part two includes seven questions, part three includes one question, part four includes ten questions and part five includes five questions. The entire questionnaire includes 36 questions that needs to be answered and it takes approximately 30 minutes to finish everything.

What is your gender?

Male = Female =

Survey part 1:

The next statements will assess how impactful you think the lead farmers initiative has been in Malawi. It will assess how far the initiative have come and how much more needs to be done. Please rate every statement as objectively as possible. By answering 1 you say that there has been no improvement since the project started and by answering 10 you say that the project is fully improved and that the farmers can continue independently without the help of outside organizations.

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The initiative allows for improved food accessibility and nutrition security":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The initiative allows for improved food diversification to combat malnutrition":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The initiative allows for improved production and increased yields":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The initiative allows for improved diversification of livestock":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The initiative allows for improved capacity to adapt to climate related stresses or challenges":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The initiative allows for improvement in climate related disaster risk reduction":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The initiative allows for improvement in the household economy":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The initiative allows for improved soil quality, fertility and water storage capacity":**

Survey part 2:

The next statements will assess the Follower Farmers improvement of Climate knowledge. It will assess how much knowledge they obtain at this point and whether they should learn more or not. Please rate every statement as objectively as possible.

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **«People in the organization have a widespread knowledge of climate science and would be able to give a logical and reflective definition of this term":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **«People in the organization have a widespread**

knowledge of Agricultural technologies and would be able to give a logical and reflective definition of this term":

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **«People in the organization have a widespread knowledge of Crop rotation and would be able to give a logical and reflective definition of this term":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **«People in the organization have a widespread knowledge of Intercropping and would be able to give a logical and reflective definition of this term":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **«People in the organization have a widespread knowledge of Making organic fertilizer and would be able to give a logical and reflective definition of this term":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **«People in the organization have a widespread knowledge of Current impacts of climate change in Malawi and would be able to give a logical and reflective definition of this term":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **«People in the organization have a widespread knowledge of Future impacts of climate change in Malawi and would be able to give a logical and reflective definition of this term":**

Survey part 3:

List all the weather-related threats/hazards experienced by farmers in Malawi and what systems they impact on by filling in an X in the relevant boxes in the list below:

Threat/hazard	Crops	Livestock	Household	Human life	Infrastructure	ecosystems	Other
Floods							
Droughts							
Pests							
Landslides							
Rockfalls							
Extreme rain							
Change in seasonality							
Extreme heat							
Frost							
Soil erosions							
Others/ please list							

Survey part 4:

The next statements will assess the Follower Farmers improvement of creating weather related resilience. It will assess how much knowledge they obtain at this point and whether they should learn more or not. Please rate every statement as objectively as possible.

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The lead farmer initiative has allowed farmers to be more prepared for floods"**:

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The lead farmer initiative has allowed farmers to be more prepared for Droughts":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The lead farmer initiative has allowed farmers to be more prepared for Pests":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The lead farmer initiative has allowed farmers to be more prepared for Landslides":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The lead farmer initiative has allowed farmers to be more prepared for Rockfalls":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The lead farmer initiative has allowed farmers to be more prepared for Extreme rain":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The lead farmer initiative has allowed farmers to be more prepared for Change in seasonality":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The lead farmer initiative has allowed farmers to be more prepared for Extreme heat":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The lead farmer initiative has allowed farmers to be more prepared for** Frost**":**

On a scale from 1 – 10, (1= no improvement, 5 = some improvement, 10 = fully improved) please rate the following statement, **"The lead farmer initiative has allowed farmers to be more prepared for If others/ please list":**

Survey part 5:

On a scale from 1 – 10, (1= not agree, 5 = somewhat agree, 10 = agree) please rate the following statement, **"Some FFs previously stated that it takes too long to experience benefits from the program because their yields have failed to increase, and it takes too long to receive livestock?":**

On a scale from 1 – 10, (1= not agree, 5 = somewhat agree, 10 = agree) please rate the following statement, **"Some farmers have previously stated that the LF training is too short which in turn might lead to knowledge drain and poorer training of FFs, rate from 1-10?":**

On a scale from 1 – 10, (1= not agree, 5 = somewhat agree, 10 = agree) please rate the following statement, **"Some LFs has previously stated that they are being overworked as they have too many Follower farmers each, rate from 1-10?":**

On a scale from 1 – 10, (1= not agree, 5 = somewhat agree, 10 = agree) please rate the following statement, **"would we experience that LFs motivation to work would be improved if they obtained a salary or compensation like they do in the Barefoot doctors' initiative, rate from 1-10?":**

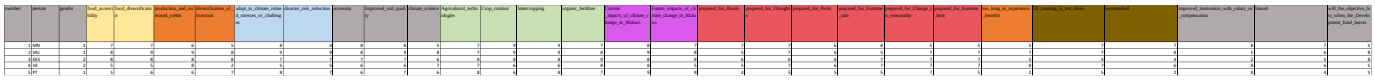
On a scale from 1 – 10, (1= not agree, 5 = somewhat agree, 10 = agree) please rate the following statement, **"Some community members have previously stated that the selection process to be an LF and to gain livestock at an early stage is biased. They believe that progressive or elite farmers has been picked before other farmers, rate from 1-10?":**

On a scale from 1 – 10, (1= not agree, 5 = somewhat agree, 10 = agree) please rate the following statement, **"will the objective last when the Development fund leaves, rate from 1-10?":**

Datasheets Excel

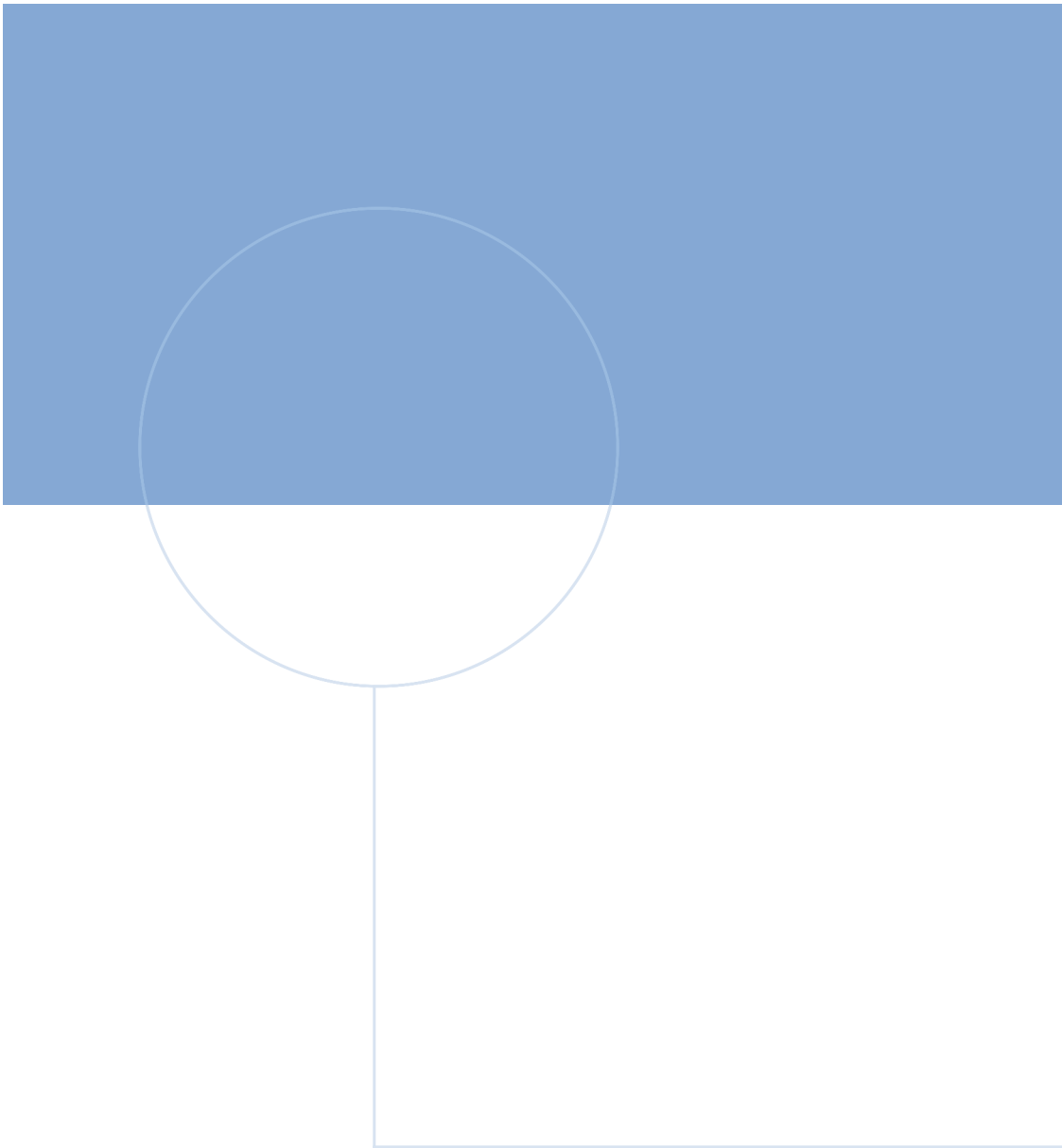
The colored sections in the first dataset represents the data that was combined and created as one for the next dataset.

1.



2.

Gender	Food_diversification_and_accessibility	Disaster_risk__reduction	Improved_economy	Improved_soil_quality	Climate_science_and_climate_change	Agricultural_technologies	Prepared_for_weather_changes	Too_long_to_experience_benefits	LF_training_is_too_short	Overworked	Improved_motivation_with_compensation	Biased_selection_processes	Will_the_objective_last
1	7	6	8	8	6,25	7,6	6	5,3	7	7	8	7	5
1	8,5	9	8	9	8,25	7,8	6	8	7	8	5	6	8
2	8	7	7	7	7	8,15	6,5	7	4	4	2	5	8
2	5	5	6	6	6,75	6,8	6,5	6	7	6	8	6	5
1	5,5	7,5	6	7	7,5	7,5	5,16	5	5	2	8	4	5



NTNU

Norwegian University of
Science and Technology